Appendix 5.

List of Equipment

(Task 9, 11, 12 Report: Industrial Monitoring).

INDUSTRIAL MONITORING

CITY OF INDIANAPOLIS
DEPARTMENT OF PUBLIC WORKS

INDUSTRIAL PRETREATMENT PROGRAM

TASK 9, 11, 12 REPORT

Peat, Marwick, Mitchell & Co.

JAMES M. MONTGOMERY
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EMS Laboratories/
Mark Battle Associates, Inc.

APRIL 1983

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April 12, 1983

City of Indianapolis
Department of Public Works
2460 City-County Building
Indianapolis, IN 46104

File No. 1180.0010

Attention: Mr. Richard Rippel, Director

Subject: Indianapolis Pretreatment Project
Task 9, 11, and 12 Report: Monitoring Program

Gentlemen:

Enclosed is the Final Draft Task 9, 11, and 12 Report: Monitoring Program for the Indianapolis Pretreatment Program. This report reviews the existing industrial discharge monitoring program in Indianapolis and makes recommendations for improvements.

This Monitoring Program Report summarizes the current sampling activities of the Indianapolis Industrial Surveillance Branch (ISB), and suggests changes in operating procedures that will focus ISB efforts on industrial discharges in proportion to their potential impact on the AWT plants and the White River. The report also reviews the sampling equipment now available to the ISB as well as the analytical equipment in use in the Belmont laboratory and identifies additional equipment needed to conduct a pretreatment program in accordance with EPA and Indiana State guidelines.

This report has been prepared in close cooperation with Peat, Marwick, Mitchell & Co. who are producing reports discussing related aspects of the pretreatment program such as staffing and funding. Mark Battle and Assoc. has provided valuable help in collecting and organizing much of the information on current ISB activities on which this Monitoring Report is based.

We anticipate that you will find this report useful to both the ISB and the Belmont laboratory during the implementation of the Indianapolis Pretreatment Program. This Final Draft incorporates comments made by the City of Indianapolis since the March 14 draft was issued, and should be suitable for submittal to EPA. If you have any questions, please call me.

Very truly yours,

Christopher B. Cain

Christopher B. Cain
Project Engineer

/gl
Enclosure

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CHAPTER 1

CHAPTER 1

INTRODUCTION

BACKGROUND OF PRETREATMENT PROJECT

The City of Indianapolis has recently started up two large advanced waste treatment (AWT) facilities to treat the wastewater produced by the citizens and industry located within Marion County, Indiana. There are several large industries located in the Marion County area, including numerous pharmaceutical plants, automative assembly plants, and other heavy industries. The potential for priority pollutant discharge is significant, and the need for an industrial wastewater pretreatment program has been demonstrated.

Due to the large number of industries, it is important that the ordinance, which limits industrial discharges, be properly documented to maximize the utilization of the City's wastewater treatment facilities. The industries in Indianapolis accept that they must discharge wastewater that is suitable for treatment in the advanced waste treatment facilities. However, they are also concerned about the potential cost impact that the installation of pretreatment facilities would have. As a result, substantial efforts have been made to provide the technical information required to justify the establishment of discharge concentration limits on various pollutants tailored particularly for the City of Indianapolis. In spite of the promulgation of categorical pretreatment standards by the U.S. Environmental Protection Agency (EPA) for certain industries located in Indianapolis, it is important to establish a reasonable and enforceable local ordinance to protect the operation of the $250,000,000 AWT facilities in Indianapolis.

Additional concerns in the Indianapolis area involve the discharge of up to 250 mgd of treated wastewater into the White River where the ten-year, seven-day low flow is approximately 35 mgd. Thus, the potential concerns for the impact of these discharges is significant for this reach of the White River. The work required to characterize the potential impact is being conducted concurrently with the to start-up of the AWT plants to establish baseline data to evaluate the improvements in in the White River system attributable to the AWT plants.

The purpose of the pretreatment project is to establish a technically sound Industrial Waste Ordinance for discharges to the Indianapolis wastewater system. The primary emphasis has been to establish meaningful priority pollutant discharge limits to protect the new AWT facilities. Substantial funds have been committed to both the planning and construction of these facilities. Ongoing efforts are being expended for the control of combined sewer overflows and for the study of sludge management alternatives. Both of these studies interact with the industrial pretreatment program due to the impact of priority pollutant accumulation and/or discharge via these routes. Compatible levels of priority pollutants which enter the treatment facility are either discharged in the effluent, accumulated in the sludge, or degraded or removed during treatment. Higher levels of these materials can result in violation of the City's NPDES permit due to upset of the treatment facilities and interference with the removal of conventional pollutants or impact on the economics of the feasibility of sludge disposal. Since the pretreatment project was initiated in the fall of 1981, the project team has completed a number of major study activities and made progress toward completion of others.

Peat, Marwick, Mitchell, & Co. (PMM) has completed the process of surveying the industries in Indianapolis and publishing the sewer user list in the Task 1 Report. PMM has also issued the Task 2 Report outlining notification procedures to be implemented in Indianapolis to inform affected industries of regulatory actions. James M. Montgomery, Consulting Engineers, Inc. (JMM) has conducted a wastewater sampling and priority pollutant analysis program at the two existing Indianapolis treatment plants, and has reported the resulting wastewater characterization in the Task 3 Report. JMM has also designed, constructed, and started up a pilot Advanced Wastewater Treatment (AWT) plant on-site in Indianapolis, and has completed a schedule of experiments designed to provide the technical information needed to support a revised Industrial Waste Ordinance. The Task 4 report presented the results of this pretreatment pilot plant study. Thus, this current Monitoring Program Task Report is one of a series of steps being taken to protect the Indianapolis AWT's and the White River from industrial pollution.

SCOPE

The objective of this Monitoring Program Task Report is to present part of the management plan of the industrial monitoring program. This report was prepared as part of the Indianapolis Pretreatment Project, conducted by JMM and PMM, acting as consultants to the Department of Public Works of the City of Indianapolis. This report fulfills the requirements for the Industrial Monitoring Program in the Pretreatment Program Plan of Study. This report deals with the following Plan of Study Task requirements:

1. Develop a Monitoring Program (Task 9)
2. Sampling Equipment Requirements (Task 11)
3. Municipal Laboratory Requirements for Monitoring (Task 12)

The development of a monitoring program includes the definition of a rational system for sampling industry and requiring self-monitoring to ensure compliance with pretreatment limitations. The system should assign monitoring requirements to each industry in proportion to its mass discharge and thus focus the sampling and analytical effort on large industries likely to contribute significant loads to the public treatment system. In addition to the overall rationale for monitoring, the program includes a review of existing sampling equipment and recommendation of any additional equipment needed, along with a description of standard operating procedures for sampling. The monitoring program also includes a review of existing laboratory facilities and recommendation of additional needed equipment.

RELATIONSHIP WITH OTHER PRETREATMENT REPORTS

The fundamental goal of the pretreatment project is the control of impacts caused by industrial waste discharges to City sewers in accordance with EPA and State of Indiana guidelines. The primary tool for control of industrial waste discharges to City sewers will be a thoroughly reviewed and revised Industrial Waste Ordinance for the City of Indianapolis which will be presented in the Task 5 Report. The ordinance will be based upon the existing Industrial Waste Ordinance, upon EPA pretreatment regulations and categorical pretreatment standards, and upon the technical information developed during the City's pretreatment project. The EPA has published a list of priority pollutants which it intends to regulate under municipal pretreatment programs in the United States. The previously published Task 3 and Task 4 Reports identified those priority pollutants which will need to be regulated in Indianapolis, by determining whether the compounds are or could be expected to be present in City wastewater, and whether they could impact the AWT's or the River. The previously published Task 1 Report presented the list of Industrial Users of the Indianapolis City Sewers as well as the available data defining the pollutants in their discharges. The Monitoring Report puts the User List from the Task 1 Report together with the list of important pollutants from the Task 3 and Task 4 Reports and develops a program of sampling and analysis that will enable the City to enforce compliance with the Industrial Waste Ordinance.

APPROACH

The approach to developing an industrial monitoring program is divided into three major subsections. The first subsection considers the essential program elements of the industrial monitoring program and provides the basis for the remaining two subsections (Chapters 4 and 5) on sampling equipment requirements and laboratory requirements.

The essential program elements are discussed in Chapter 3 of this Monitoring Program Report. In this chapter, the rationale for industrial and POTW sampling is developed. The rationale developed is based on acquiring an adequate statistical base to judge sample values and the categorization of industry by its potential load contribution to the POTW.

The sampling equipment requirements are presented in Chapter 4. From the monitoring program requirements developed in Chapter 3 and existing ISB and POTS sampling equipment, the need for additional sampling equipment for industrial monitoring can be developed. Chapter 5 discusses the laboratory analytical capabilities and recommendations for additional equipment to support ISB industrial and POTW sampling activities.

AUTHORIZATION

This report has been completed in accordance with the terms and agreement between the City Indianapolis and James M. Montgomery, Consulting Engineeers, Inc., in the Final Contract for Developing a Municipal Pretreatment Program, dated July 13, 1981.

ABBREVIATIONS

To conserve space and improve readability, the following abbreviations have been used throughout this report:

AWT	advanced wastewater treatment
ADWF	average dry weather flow
BOD	5-day Biochemical Oxygen Demand
City	City of Indianapolis
Department of Health	Indiana State Department of Health
DPW	City of Indianapolis Department of Public Works
EPA	U.S. Environmental Protection Agency
^{o}F	degrees Fahrenheit
ft	feet
gal	gallons
GC	gas chromatagraph
GC/MS	gas chromatagraph/mass spectrophotometer
gpd	gallons per day
gpm	gallons per minute
hp	horsepower
hr	hour
in	inches
JTU	Jackson Turbidity Units
lbs/day	pounds per day
mil gal	million gallons
mgd	million gallons per day
mg/l	milligrams per liter
min	minutes
mph	miles per hour

PDWF	peak dry weather flow
POTW	Publicly Owned Treatment Works
ppm	parts per million
psi	pounds per square inch
PWWF	peak wet weather flow
rpm	revolutions per minute
sq ft	square foot
TDS	total dissolved solids
$\mu g/m^3$	micrograms per cubic meter
$\mu g/l$	micrograms per liter
yr	year

CHAPTER 2

CHAPTER 2

SUMMARY AND RECOMMENDATIONS

GENERAL

This report reviews the existing industrial pollutant monitoring facilities and programs in Indianapolis and develops recommendations for upgrading them in accordance with EPA and State of Indianapolis guidelines. Chapter three of the report develops a comprehensively designed monitoring program, while Chapters 4 and 5 develop recommendations for sampling equipment and analytical facilities (respectively) required to implement the Pretreatment Program.

MONITORING PROGRAM

The monitoring program recommended for insuring compliance with the Indianapolis Industrial Waste Ordinance is oriented around a permit system and includes both industrial self-monitoring and City monitoring of industry to the ISB. Self-monitoring is utilized for weekly routine monitoring of large industries, while the ISB is responsible for monitoring small industries which do not maintain their own laboratories and sampling staffs. The frequency of sampling is determined for each industry on the basis of its mass discharge of pollutants. Sampling frequencies range between quarterly to weekly. The ISB analyses between 4 and 10 samples for each industry for all pollutants regulated in the Industrial Waste Ordinance. Self-monitoring samples are analyzed only for those pollutants discharged at significant concentrations and specified in the permit for each industry.

The industrial monitoring program also includes regular sampling and analysis of samples taken from the influent of the Belmont and Southport Treatment Plants, as well as from selected sampling points in major sewer interceptors. These samples are analyzed for all of the industrial pollutants regulated in the Ordinance, as well as for certain organic compounds of concern in Indianapolis (solvents and phenolics).

SAMPLING EQUIPMENT

Chapter 4 of this report reviews the existing sampling equipment available to the City staff for monitoring industrial dischargers and the influent to the two new AWT plants in Indianapolis. On the basis of this review, it is concluded that while the ISB is adequately equipped for industrial discharge monitoring, the facilities currently provided for sampling the influent to the Belmont plant are inadequate. Recommendations are presented for equipment to be procured for sampling the AWT influent, as well as for improving the effectiveness of sampling of industrial dischargers and interceptor sewers.

ANALYTICAL EQUIPMENT

An inventory of the analytical equipment and facilities at the Belmont Laboratory is presented in Chapter 5, and the capability of the laboratory to perform the analyses required for the industrial monitoring program is assessed. It is found that the lab facilities include those needed for the pretreatment program, but that the laboratory workload is heavy due to the process control analyses required for the Belmont and Southport AWT plants. Several minor equipment accessories should be purchased to increase the capacity for metals analyses. A number of recommendations are made for improving operations in the laboratory. In addition, the concept of establishing a regional laboratory at Belmont was evaluated in light of the available capacity of the Belmont lab and the need for such a lab in central Indiana. It was found that there is not sufficient demand to justify a publicly operated regional laboratory, and that the Belmont Laboratory capacity will be fully utilized to meet the needs of the Indianapolis pretreatment program and the AWT plant operations.

RECOMMENDATIONS

The following recommendations are made on the basis of the material in this report.

1. The ISB should adjust its industrial discharge sampling procedures to sample industries with the frequencies listed in Table 3-5 based on the mass discharge of pollutants from each industry.

2. The ISB should adjust industrial discharge permits and adjust its own operating procedures to conform to the analysis selection system outlined in Table 3-7(b) and Tables 3-9 and 3-11 for option II-A. In general, this will mean increasing the number of metals and other pollutant analyses run on each sample by the City.

3. The ISB should rely primarily on composite samples for monitoring industries, although grab samples should be used where appropriate (as for pH or short-notice sampling).

4. The City should require large industries to continue to self-monitor both their industrial pollutant discharges and their discharges of surchargeable conventional pollutants. Small industries should be sampled solely by the ISB to insure consistency in technique.

5. A program of regular sampling in major sewer interceptors should be established to aid in the identification of the sources of problem discharges.

6. A program of regular industrial pollutant analysis of composite samples from the Belmont and Southport AWT plants should be established. This program should incorporate a procedure by which a daily composite is collected and held for several days for possible analysis in the event that unusual conditions appear in the treatment plant.

7. Refrigerated composite sample collection equipment should be installed for the Belmont AWT influent.

8. The sample equipment listed in Table 4-5 should be procured for the ISB, including flow monitoring and personnel safety equipment.

9. The laboratory operational improvements listed in Chapter 5 should be implemented.

10. The Belmont Laboratory should not be established as a regional laboratory serving central Indiana.

11. The Belmont Laboratory should procure the analytical equipment listed in Table 5-6, including auto-sampler accessories for the AA and D.C. Plasma Analyzers.

CHAPTER 3

CHAPTER 3

MONITORING PROGRAM

MONITORING PROGRAM OBJECTIVES

Laboratory analytical data which documents the composition of all significant industrial discharges to city sewers is the necessary basis for any acions to control industrial discharges. While estimates and projections made using SIC codes and other industry data are useful in planning an industrial discharge control program, monitoring of individual discharges is needed to achieve the following general objectives:

- The monitoring program must determine whether or not individual industries meet industrial waste ordinance discharge standards.

- The program must provide sufficient data to quantify the industrial pollutant loads imposed on the POTW, and to distinguish industrial loads from residential waste loads.

These general objectives are achieved at optimum cost by implementing the following monitoring program elements.

- Collect and analyze wastewater samples from all significant industrial dischargers on a routine basis. Collect enough samples to determine if industries are meeting discharge limits.

- Collect and analyze samples of wastewater from major interceptors and the influent to the POTW's. Collect enough samples to calculate the annual average industrial pollutant loads on the POTW's.

- Collect and analyze industrial wastewater samples collected on a random basis.

- Collect and analyze samples from industries which cause impact on the sewers, the POTW or the River, or which violate discharge ordinance or permit requirements, to support efforts to enforce compliance.

The program elements can be summarized as routine monitoring, random sampling and analysis, POTW influent monitoring, and compliance sampling and analysis.

Indianapolis currently operates an Industrial Surveillance Program to achieve the above objectives. This existing program is described below, along with options for modification or improvement. On the basis of this discussion, a recommended monitoring program is described.

EXISTING MONITORING SYSTEM

General

The existing routine monitoring program consists of two main components: City Industrial Surveillance Branch Monitoring and industrial self-monitoring. In addition, POTW influent and wastewater samples from certain interceptor sewers are monitored on as as-needed basis.

Industrial Surveillance Branch Sampling

The City of Indianapolis Industrial Surveillance Branch (ISB) conducts an industrial discharge monitoring program which includes both routine monitoring and problem-oriented sampling. The problem-oriented sampling will be discussed briefly below, but first the routine ISB monitoring program is explained.

The ISB routine monitoring program is a system of regular sampling and analysis of wastewater from the roughly 180 permitted industries in Indianapolis. The program is intended to verify compliance with the industrial pollutant (metals) discharge standards in the ordinance and in the permits, as well as to provide the data from which BOD and TSS surcharges are computed. The ISB sampling crews, working from a fixed list of industries, collect samples from each one approximately every three weeks. The samples are then analyzed for individual conventional pollutants, (BOD, TSS, NH_3-N, OAG, etc.) and for metals (cadmium, chromium, copper, lead, nickel, zinc, cyanide, phenols), if these compounds are specifically included in the permit. Table 3-1 presents a listing of the various frequencies with which industrial samples are collected and analyzed by ISB for pH, conventional pollutants (BOD, TSS, NH_3-N, Oil and Grease)

The list of industries which governs the activities of the ISB crews is reviewed and revised once each year on the basis of past information collected and filed on the monitored industries. Since this requires cumbersome manual scanning of the three separate files in which such information is maintained, the ISB is impaired in its ability to either match sampling routines with chronic violators or to develop a set of industrial classes which would group industries of similar polluting potential together and within which classes truly random sampling could be performed. With an efficient data management system ISB could group industries of greatest concern together and perform frequent random samples within this group. Groups of lesser concern could also be defined, and random sampling of a less intensive nature could be performed within each group. However, given the present ISB facilities, the monitoring list system is a reasonable approach to an equitable "random" sampling system.

The problem-oriented sampling in the ISB Monitoring Program consists of responding to emergency spills and taking samples to help identify the cause of high BOD loads, odors, floating oils, or other conditions noticed in the treatment plant influent or at specific locations in the sewer system. This problem-oriented sampling typically involves a small amount of sampling relative to a

TABLE 3-1

INDIANAPOLIS PRETREATMENT PROJECT
EXISTING ISB MONITORING PROGRAM
1981 Analysis Frequencies (4)

Annual Analysis Frequency	Number of Industrial Sampling Points Analyzed by ISB at the Stated Frequency			
	pH	Conventional Pollutants(1)	Metals(2)	Pollutants or Metals
48	2	2	0	0
12-23	107	93	29	105
6-11	60	50	15	62
1-5	12	18	22	12
Subtotal	181	162	66	179
Industries Permitted but not Monitored	16	34	131	18
Total Sample Points(3)	197	197	197	197

(1) Conventional Pollutants = BOD, TSS, NH_3-N, and Oil and Grease.
(2) Metals = Cd, Cr, Cu, Pb, Ni, Zn, Cyanide, and Phenols.
(3) Some industries are sampled at two or three points, resulting in two or three annual sets of samples.
(4) Data Source = Belmont Lab Analytical Results Log.

large amount of planning, administration, and coordination with industry; so although it may require a large part of the ISB budget for supervision, it contributes only about 5 to 10 percent of the ISB sampling load. The program is necessarily flexible and free-form in nature and best be described simply as the discretionary adjunct to the ISB routine monitoring program.

The tables in this section include the discretionary problem-oriented industrial discharge samples along with the routine samples, so that they are included for planning and comparison with future alternatives.

Self Monitoring

Under the existing system, permitted industries and industries that provide billing information to the city are required to self-monitor their discharges--generally for conventionals and sometimes for heavy metals. These results are submitted to ISB on a monthly basis.

The industrial self-monitoring program in Indianapolis is a system administered through the industrial discharge permits which requires each permitted industry to take and analyze wastewater samples. The permit specified the type of sample (grab or composite), the frequency, and the analyses to be run. Table 3-2 summarizes the self-monitoring program sampling and analytical frequencies for the four groups into which the permitted industries are divided.

The system can be seen to break the permitted industries into four groups with respect to metals sampling, with about 21 industries self-monitored once per month, twice per mont, and three times per month, while the remaining permitted industries are not sampled for metals at all. Thus, about 63 industries are sampled for metals. An additional 80 industries are sampled for conventional pollutants, usually at frequencies of once per month or once every other month, while about 40 of the largest discharges are sampled for conventionals twice or four times per month. In many cases, these are the same industries sampled for metals. Finally, 25 of the largest industries are required to self-monitor pH daily, and partically all of the remaining permitted industries analyze for pH at frequencies higher than those at which they analyze for conventionals or metals. In short, the self-monitoring program appears to have been set up on a systematic basis.

However, the existing self-monitoring system lacks a rationale for reviewing the analytical record for each industry and reassinging an appropriate self-monitoring routine. The records show what the self-monitoring routine is for each industry, but do not indicate clearly why the routine was set as it is, or what changes should be made in self-monitoring in response to changes in the analytical results.

It should be noted that the existing self-monitoring program uses pH analyses more than any other analysis. This may be because pH analyses are inexpensive and pH extremes are often good indications of high concentrations of other industrial pollutants. Thus, the pH analyses function as "indicator analyses" to detect deviations from normal operations and discharge conditions.

TABLE 3-2

INDIANAPOLIS PRETREATMENT PROJECT
EXISTING INDUSTRIAL SELF-MONITORING PROGRAM
1981 Analysis Frequencies (b)

Annual Analysis Frequency	Number of Industries for which Analyses are run at the Stated Frequency			
	pH	Conventional Pollutants(1)	Metals(2)	Pollutants or Metals
360	35	0	0	0
96	1	1	1	2
48	59	20	20	27
24	8	22	21	35
12	66	66	21	72
6	1	34	0	34
Subtotal	170	143	63	170
Industries Permitted but without Self-Monitoring	16	43	123	16
Total Permitted Industries	186	186	186	186

(1) Conventional Pollutants = BOD, TSS, NH_3-N, and Oil and Grease.
(2) Metals = Cd, Cr, Cu, Pb, Ni, Zn, Cyanide, and Phenols.
(3) Data Source = Self-Monitoring Reports in ISB files.

Comparison of Existing ISB vs Self-Monitoring

The existing City ISB monitoring program and the industrial self-monitoring program are intended to work together to provide the City with the information needed to verify compliance with the industrial waste ordinance. Self-monitoring is employed to gather much of the routine data for each industry because this method automatically places the cost of the work on the responsible industry, and because large industries can most efficiently monitor their own wastewater. Industries are familar with their own sampling situation and have technical personnel stationed close by to perform sampling chores.

On the other hand, the City needs to check the accuracy of industry self-monitoring results to guard against systematic sampling errors to be sure differences in analytical techniques do not affect the data accuracy and remove the grounds for conflict-of-interest accusations aimed at industry which otherwise might be in a position to manipulate data. City monitoring is also useful for finding unsuspected waste discharge sources or detecting changes in industrial discharges of which a self-monitoring industry may be unaware. It is therefore instructive to compare the existing ISB and self-monitoring programs. Table 3-3 presents a summary of the two programs side-by-side in terms of the frequency of analyses for different groups of industries. Because the ISB sampling program theoretically treats all industries the same (by sampling each one every three weeks), the table is arranged according to the self-monitoring groupings.

The comparison of the existing ISB and self-monitoring programs in Table 3-3 illustrates several aspects of the current situation that may indicate a need for improvement. While the table indicates that the level of effort in City sampling tends to be greater for those industries which self-monitor with high frequency and less for those which self-monitor infrequently, the range of ISB monitoring frequency for any one group is relatively large. For example, while all 35 industries in the bi-monthly self-monitoring group were judged to be sufficiently similar to warrant self-monitoring at the same rate, the ISB monitors some only two times per year and others as often as 19 times. To an extent, frequent ISB sampling may be due to the influence of the problem-oriented special sampling discussed earlier, but it is not sensible to require two industries to self-monitor at a rate of 24 samples (one every three weeks) on one and only two samples for the other. A second example of lack of coordination between the two programs is the fact that between seven (1981) and twelve (1982) industries self-monitored for metals without any ISB monitoring of metals. Therefore, it appears that more coordination is needed between the ISB and self-monitoring programs.

Compounds Analyzed (Task 9.2)

The compounds which are currently sampled for by ISB appear to have been determined as the essential compounds of concern. Most of them are compounds which are regulated and monitored by many cities across the country.

TABLE 3-3

INDIANAPOLIS PRETREATMENT PROGRAM
EXISTING INDUSTRIAL MONITORING PROGRAM
ANALYSIS FREQUENCY GROUPING
(1981 Data, excluding pH analyses) (3)

Group	Industrial Self-Monitoring		City ISB Monitoring
	Number of Industries in Group	Annual Number of Self-Monitoring Conv. Pollutant or Metals Samples	Annual ISB Conv. Pollutant or Metals Samples
Self-Monitoring 4 times per month	29	48 (1)	8-17 (2)
Bi-monthly Self-Monitoring	35	24	2-19
Monthly Self-Monitoring	72	12	4-16
Self-Monitoring every two months	34	6	0-10
Total Industries:	170		

(1) Two industries monitor 96 samples per year.
(2) One industry is sampled 48 times per year by ISB, with 2 sample points, totalling 96 samples/year.
(3) Source of Data = 1981 Self-Monitoring Reports in ISB files.

Each industry in Indianapolis is required to report on an Application for Industrial Discharge Permit whether it believes any of the following substances are present in their discharge: cadmium, chromium (HEX), oil, grease, chlorinated hydrocarbons, insecticides, explosives, suspended solids, BOD, and ammonia. The industries are not initially required to measure or report the quantity of each pollutant. ISB samples the discharge from industries whose permit applications indicate that the user's discharge might contain excessive pollutants or represent a hazard to the sewer system. Industries whose applications indicate the likelihood that no problem will arise from the user's discharge are allowed to operated without a permit.

When it is determined which, if any, pollutants might be present in excessive quantities in a user's discharge, limitations on those pollutants are determined by the ISB chief and incorporated into the industry's permit. ISB crews will thereafter normally sample only for those pollutants specified in the permit. Exception to this rule may be made when a particular pollutant is believed to be entering the sewer system from a certain source.

Existing Monitoring Workload

While the information in Tables 3-1 and 3-2 summarizes the workload for the ISB and industry sampling crews under the existing program, they do not show in detail which metals or conventional pollutants are run on which samples. Tables 3-4a and 3-4b present a more detailed summary of the total number of analyses of each type that were run in 1981 and 1982, as well as the number of grab samples vs composite samples taken.

A number of significant observations can be made based on this table. First, while a very large number of pH grab samples are taken as part of the industrial self-monitoring program, the City only runs pH on the samples taken for analysis for other compounds, and so does not rely as heavily on this parameter. This is sensible in that the cost to industry for taking and analyzing a pH grab sample is much less than for the ISB, which must spend travel time to get each sample.

A second observation made based on Table 3-4 is that there is a relatively even balance (40 percent - 60 percent) between ISB composite sampling and industrial composite sampling. Thirdly, it is useful to calculate the average number of conventional analyses and metals analyses run on each sample. Such numbers are useful for estimating future workloads. It is convenient to differentiate between conventional pollutant analyses and metals because the cost for each conventional analysis is usually about $25, while the cost per metal analyzed is generally about $12. The difference is due to the fact that conventional analyses are run with separate apparatus and sample preparation procedures for each type of analyses, while metals are all run with one piece of equipment after one sample preparation procedure. In any case, the ISB typically runs an average of 1.3 conventional (non-pH) analyses and 0.4 metals analyses on each sample taken (composites and grabs). On the other hand, self-monitoring industries typically run 1.3 conventional (non-pH) analyses and 1.8 metals analyses on each composite sample taken.

TABLE 3-4

INDIANAPOLIS PRETREATMENT
SAMPLING AND ANALYTICAL FREQUENCIES
AS A FUNCTION OF INDUSTRIAL GROUPS

Routine Sampling Program	Routine Analytical Program	Industrial Subgroups	Count of Industries in Subgroups 1982	Count of Industries in Subgroups 1984
1 Composite per week	Analyze 10 samples/year (sa/yr) for 20 pollutants[a]. Analyze 42 sa/yr for pH, TSS, COD, O&G, and average of 5 metals (or phenol), as specified on permits. DO BOD, NH_3-N, and TKN on 50% of samples.	1-A,1-B	26	24
1 Composite per week	Analyze 10 sa/yr for 20 pollutants. Analyze 42 sa/yr for pH, BOD, TSS, COD, NH_3-N, TKN, and O&G.	2-B	3	6
2 Composites per month	Analyze 8 sa/yr for 20 pollutants. Analyze 16 sa/yr for pH, TSS, COD, O&G, and average of 5 metals (or phenol). DO BOD, NH_3-N, and TKN on 50% of samples.	3-A	0	2
2 Composites per month	Analyze 8 sa/yr for 20 pollutants. Analyze 16 sa/yr for pH, BOD, TSS, COD, NH_3-N, TKN, and O&G.	3-B	0	2
2 Composites per quarter	Analyze 8 sa/yr for 20 pollutants.	1-C, 1-D, 1-E, 2-D 3-D, 4-A 4-B, 4-C 4-D, 4-E 4-F, 5-A 5-B,6-A,6-B	195	202

TABLE 3-4 (continued)

Routine Sampling Program	Routine Analytical Program	Industrial Subgroups	Count of Industries in Subgroups 1982	Count of Industries in Subgroups 1984
2 Grabs per year	Analyze 2 sa/yr for 20 pollutants.	3-E, 3-F 5-D, 5-E 5-F, 6-C 6-D	134	100
1 Grab per 5 years on a random basis	Analyze 0.2 sa/yr for 20 pollutants.	6-E,6-F	428	410

(a) The list of 20 pollutants is per Table 3-6.

TABLE 3-4a

INDIANAPOLIS PRETREATMENT PROGRAM
EXISTING ISB MONITORING AND INDUSTRY SELF-MONITORING PROGRAM ACTIVITIES
1981 DATABASE (2)

Analysis	Number of Samples Analyzed Per Year	
	City ISB Monitoring	Industry Self-Monitoring
Grab Samples	1,076 (1)	18,006
Composite Samples	1,240 (1)	3,330
pH	2,144	18,006
BOD	1,051	1,200
SS	1,545	1,742
O&G	205	1,122
NH_3	165	252
Phenols	224	402
CN	367	1,044
Cd	45	588
Cr (VI)	0	1,146
Cu	73	844
Pb	15	204
Ni	92	916
Zn	76	904
Total Samples	2,316	21,336

(1) Estimated spilt of sample count between grabs and composites.
(2) Source of Data: 1981 ISB files of Self-Monitoring data and Belmont Lab files of ISB Monitoring data.

TABLE 3-4b

INDIANAPOLIS PRETREATMENT PROGRAM
EXISTING ISB MONITORING AND INDUSTRY SELF-MONITORING PROGRAM ACTIVITIES
1982 DATABASE (1)

Analysis	Number of Samples Analyzed Per Year	
	City ISB Monitoring	Industry Self-Monitoring
Grab Samples	996	16,902
Composite Samples	1,155	3,116
pH	2,151	16,926
BOD	1,022	1,200
SS	1,460	1,764
NH_3	195	204
O&G	435	1,122
Phenols	205	372
Cyanide	384	1,044
Cd	201	588
Cr (VI)	44	1,045
Cu	290	844
Pb	104	204
Ni	373	916
Zn	376	952
Total Samples	2,151	20,018

(1) Data Source = 1982 ISB files of Self-Monitoring and ISB monitoring data.

It is significant that neither self-monitoring industries nor the ISB currently rely on grab samples to any great extent for routine monitoring of metals or conventional pollutants. It is also interesting that the ISB runs far fewer metals analyses per sample than do self-monitoring industries. This may be because of limitations on City laboratory facilities during the construction and start-up of the AWT plants. The capability to run metals analyses was added to the Belmont City laboratory as part of the new plant construction activity, and was not completely staffed in 1981.

POTW and Interceptor Sampling

The existing POTW sampling program for industrial discharges consists of slug discharge reports. Slug discharge reports are initiated by operations personnel on the basis of physical observations (color, smell, or visual observations) made of the POTW influent. A sample of the influent to the POTW during the slug incident is collected by operations personnel, and the incident is reported to ISB. The sample report contains information on the nature of the slug, its time and duration, the individual who observed the slug and collected the sample, and other information or comments about the sample.

Upon receiving the slug discharge report, the ISB determines what analyses, if any, are to be performed, and sends the sample to the municipal laboratory or to an outside laboratory for the analyses. The ISB, on occasion, may follow-up on slug discharge reports based on their knowledge of Indianapolis industries and on the nature of the slug, and enter explanatory comments on the slug report.

An occasional slug discharge is detected in the collection system by sewer maintenance crews or by ISB personnel. Sewer samples are generally collected by ISB personnel and are treated in the same manner as POTW reported slug discharges.

An interceptor sampling program at the Belmont POTW was started in the summer of 1982 for the analyses of conventional pollutants. This program was started after several high load incidents caused operational problems. The program was started for two reasons, to obtain information on the wastewater from each interceptor, and to determine on which interceptor the high load was entering the plant.

The ISB takes samples as necessary for enforcement purposes or to solve special problems. The numbers of these samples are included in Tables 3-4a and 3-4b.

MONITORING PROGRAM OPTIONS

The monitoring of industrial discharges can be accomplished through a program of sampling by ISB crews, by the industries themselves, or through a combination of the two. Most of the options that may be considered for running a monitoring program have to do with variations in the level of monitoring effort between the City and industries. These options can be summarized in terms of the following two basic options:

- a problem-oriented self-monitoring program; and
- a full-scale city monitoring program.

The advantage and disadvantages of each of these options are considered below.

Problem Oriented Self-Monitoring Program

A problem oriented self-monitoring program would be one which adjusts the monitoring effort by the city to the minimum required to effectively insure compliance with the industrial waste ordinance.

In this option, a data management system would be utilized to identify those industrial users which pose the greatest threat to the sewer system due to their volume, strength, toxicity, or history of chronic violations. Such users, once identified, could be required to self-monitor on a frequent basis and in addition would be subject to more frequent verification monitoring by the city.

The data management system, based on industrial survey data and incorporating data from other sources, would be used to prioritize those industries which owing to their volume, strengths, toxicity, history of violations, or a combination of these would be of the most concern to the City. Such a system would expand in its usefulness as data from self-monitoring and sampling reports were entered. This data, over time, would provide a historical record of industries' discharges to the sewer system. Such a record would be invaluable in pinpointing problem industries.

Currently, the ISB operates an organized sampling program which samples the major industries on a frequent and routine basis. In addition, non-routine samples are made at fires, spills, and other emergency incidents.

The existing monitoring program does a creditable job of receiving and analyzing self-monitored reports and of sampling permitted industries. Still, there are weaknesses in the program which need to be addressed. These problems stem more from a data management problem than from a staff problem.

All data which currently comes into ISB is manually handled and stored. Self-monitoring data and sampling data are filed separately. The difficulty of manipulating such large quantities of paper has prevented ISB from developing a sound rationale for its sampling routines. Current sampling routines are developed manually on a non-random basis. There is no system for using the accumulated data to systematically discover the most chronic or most serious violators and for directing increases sampling activity to them. Some industries submit self-monitoring forms to both ISB and the User Charge department. There is no system for cross-checking data on these forms or for comparing them with sampling data. These issues will be addressed more thoroughly in the section on data management.

The existing system of self-monitoring supplemented by city monitoring would be much more effective if the data derived from such monitoring were more intensively and efficiently utilized. There is nothing wrong with the concept of requiring major dischargers to self-monitor, and backing up such self-monitoring with city sampling. The system saves the city from what would be considerably increased effort, if it had to be solely responsible for monitoring. The self-monitoring requirement also serves the function of drawing industry's attention to their own discharges. This could well be a first step in encouraging industry to accept a responsible attitude towards these wastes. In summary, there is no reason to assume that the present program is ineffective. What is most needed is an efficient data management program which will direct ISB's attention to the most serious problem dischargers.

An essential contribution of an effective data management system is that it enables ISB to establish a random sampling approach based on parameters to be sampled. Using such a system, ISB would set up a series of classes for industries, such as:

- industries with pretreatment plants;
- toxic dischargers;
- industries with heavy discharges of conventional pollutants;
- categorized industries with no process discharge; and
- discharges of sanitary waste only.

Using the above or similar system based on considerations of volume, strength, and toxicity, ISB will be able to ordain a rational random sampling schedule. Those classes of industry which are believed to pose the greatest threat to the POTW and to the sewer system will be sampled most frequently. ISB will periodically review its files and develop a random weekly sampling schedule for each class which will take into consideration the amount of time that has passed since a particular industry has been sampled or its history of violations. The prioritization of industries will vastly improve the ISB Chief's ability to obtain optimal use of his resources.

The above classification system, or another one based on similar considerations of volume, strength, toxicity, or historical violations, will also be used to determine the frequency with which industries will be required to self-monitor. Industries in classes which are deemed to be most threatening to the POTW and to the sewer system will be required to self-monitor their wastes more frequently than has hazardous industries.

Under this problem oriented option, ISB will be expected to coordinate with the POTW much more closely than it does in the existing program. Lines of communication between ISB and the POTW will need to be redrawn and strengthened so that information on a potential problem known to one branch will be quickly transferred to the other. Increased sampling at the POTW will allow ISB to have a better idea of which parameters are raising the greatest problems. The enhanced data management system will assist ISB to locate and identify the probable dischargers of those parameters.

ISB will probably benefit from quarterly, rather than an annual assessment of its sampling priorities under this option. The improved data management system will facilitate this task. A quarterly assessment of sampling priorities will be sent to industry and will make optimal use of ISB resources.

Full-Scale City Monitoring Option

This option might better be termed a "minimal self-monitoring option" since EPA regulations do not permit POTW's to entirely eliminate industries of a self-monitoring requirement. 40CFR403.12(b)(7)(e) requires, at best, semi annual monitoring for industrial users subject to a pretreatment standard. Although this requirement relates only to the planned categorical standards rather than to any existing standards, the likely passing of these Categorized standards in the near future means that any monitoring program should include provisions for at least some self-monitoring. It will be simpler and more efficient to design a monitoring program which requires submission of self-monitoring reports by all those industries likely to be affected by the categorized regulations, and to have these reports submitted from the very beginning of the program rather than identify and notifying separate groups of industries each time a new standard is passed. Industries under this option would be required to submit only the minimum two self-monitoring reports per year required by 40CFR403.12(b)(7)(e).

Under this option ISB's enhanced data management system would identify those industrial users liable to be subject to a categorized standard. Those industries would be notified of their obligations to submit bi-annual self-monitoring reports. All other sampling and monitoring would be through ISB.

There are some advantages of both the City and industry in minimizing self-monitoring. The City gains greater control over the entire sampling process and avoids such potential problems as falsification of data by industry or careless techniques being used by a commercial laboratory. Since the City will have almost full control over sampling and monitoring, there will be one less area of potential friction between the City and industry. ISB will have a reduced burden of enforcement cases related to falsification of data and submission of self-monitoring reports. From the industries point of view, there will be the reduced administrative burden of having to be responsible for sampling and submitting reports. Costs will probably not vary appreciably for most industries from those they pay under a self-monitoring system.

A disadvantage to the City includes the fact that if it undertakes the burden of performing almost all sampling and monitoring, it will be forced to improve its data management system and expand its current field and laboratory staff.

Improvements in the data management system are those discussed in previous options and in the section on data management. They will include the ability to identify and prioritize industries on the basis of volume, strength, toxicity, chronic violations, or combinations of these. The size of the ISB labor force needed to monitor industry will depend on the system the City adopts for classifying industries and the intensiveness with which it chooses to monitor each class. In any event, it can be assumed that increased sampling and laboratory personnel will be needed to make up for the loss of self-monitoring data.

Dispensing with the requirements to self-monitor will remove an inconvenience from industry. The chief disadvantage to industry of this action will probably be that industries will no longer have their own records documenting their good behavior. Industries will be forced to rely on the results of ISB sampling and, in order to challenge such data, will have to go to extraordinary efforts.

An important advantage to the City of doing its own sampling is the continuity derived from the operation. City crews can be trained to observe careful chain-of-custody procedures and to ensure that company officials observe and sign off on sampling procedures. The city crews can then bring samples to a city lab where quality control procedures can be observed. City lab staff can be familiarized with all necessary techniques for testing and handling.

If the City increases its monitoring activity, it inevitably will take on somewhat the role of an unpaid consultant to industry. Although this may be viewed by some as a disadvantage, there are also positive aspects to such a relationship. Having the City perceived as being available to advise and assist industry does much to move the relationship away from one of adversaries and towards one of partnerships. It also recognizes the fact that many industries have a low level of technical competence in this area and can benefit from the advice and assistance from ISB experts.

A program of full-scale city monitoring will benefit from increased cooperation between ISB and the POTW in the areas of sampling and information exchange. As in the problem oriented self-monitoring options, ISB will be able to optimize resources and improve equitable treatment of industry by utilizing an enhanced data management system to reassess its sampling priorities on a quarterly rather than on an annual basis.

DESCRIPTION OF RECOMMENDED MONITORING PROGRAM

Basis for Monitoring Industries

The basis for monitoring industries consists of answers to the following questions:

- How frequently should each industry be sampled?
- What type of samples should be taken?
- What analyses should be run on the samples?
- Who should take the samples?

- Which laboratories should analyze the samples to insure data verification?

Sampling Frequency. Samples of wastewater from industrial discharges, sewer interceptors and POTW influent must be taken often enough to be representative of the normal character of these flows, while not incurring unnecessary sample costs. In theory, it would be best to collect daily flow-proportioned 24-hour composite samples from each sample location. The minimum length of time for which a single average or maximum concentration should be calculated to characterize an industry's discharge is one year. Shorter periods of time would require seasonal adjustments or sets of multiple values. In other words, if averages were calculated over a six-month period, both the summer and winter values should be stated to fully characterize a discharge, and all 12 averages are needed to describe an industry using monthly averages. The use of annual averages is consistent with industry planning and accounting practices, which generally assume a yearly cycle. For small industries, an averaging or characterization period longer than a year may be adequate because changes in their discharges do not become important until a number of industries implement changes. Nevertheless, the basic sampling period upon which this industrial monitoring frequency analysis is based is one year.

For large industries which individually contribute a significant portion of the total AWT pollutant load, ("significant" is as defined below), the monitoring program is designed to take enough samples to calculate the average concentration for any important pollutant with an accuracy of ± 25 percent at a confidence level of 99 percent. This approach will allow for normal analytical variability (approximately ± 25 percent) without unnecessarily sacrificing confidence in the sampling results.

It is assumed that the variations in the concentration of any industrial discharge around the actual (population) mean are randomly distributed and thus fit the standard normal distribution. It is also assumed that the number of daily composite samples analyzed (n) in any year is small compared to the number of days in the year. Under these conditions, the mean ($\bar{X}$) of n samples will be equal to the population mean (μ) within a tolerance (error) of E with probability of $1-2_x$, where E is defined by the "Student t" distribution. (Ref. 1, pages 148-149). Stated in mathematical terms;

$$(\bar{X} - \mu) < (t_x / \quad n)S = E$$

with a probability of $(1-2_x)$, where

n = number of analyses per sampling period

$\bar{X}$ mean value of n sample analytical results

μ = population mean (actual mean) of industrial discharge concentration

s = sample standard deviation

E = error = $| \bar{X} - \mu | = 0.25\ \bar{X}$

t_x = value of the student-t variable for which the area under the right of t is /2

x = 1 minus the confidence level, expressed as a fraction

The numbers of samples (n) required to calculate $\bar{X}$ with several confidence levels and error tolerance values are tabulated below (per Table IV in Ref. 1).

Confidence Level (Probability)	(n) Number of Samples Required for $E = \frac{t_x}{n}(S) = S$ Column 1	$E = \frac{t_x}{n}(S) = 0.5(S)$ Column 2
90%	6	12
95%	8	24
99%	12	48

It is assumed that the sample standard deviation S for industrial discharges is typically between 1/2 ($\bar{X}$) and 1/4 ($\bar{X}$).

$$E = \underline{+}25 \text{ percent of } \bar{X} = \underline{+}0.25\ \bar{X} = \frac{t_x}{n}(S) = S = \frac{t_x}{n}(1/2)\ \bar{X}$$

or

$$\frac{t_x}{n} S = 1/2\ S$$

It is recommended that 48 samples per year be taken to calculate the average concentration for industries with significantly large discharge loads. It is also recommended that after one or two years of data collection, the actual values of S for each industry should be reviewed. The sampling frequency for any industry for which S is less than 0.25 ($\bar{X}$) should be reduced to 12 samples per year, according to column 1 in the above table.

While the monitoring program is designed to generate an accurate estimate of the annual mean industrial pollutant loads on the POTW's it is not necessary to measure the average discharge from each industry. Except in the case of industries which individually discharge a significant portion of the POTW load, it is only intended that enough samples be taken to assure that each industry is meeting the maximum discharge concentration standard. Because the monitoring of individual industrial toxic pollutant discharges is intended only to determine whether the discharge is "acceptable" or not, statistical acceptance sampling procedures are appropriate. One widely used standard acceptance testing plan is contained in Military Standard 105D (Ref. 1). According to this plan, if 13 test items are collected and no more than one is found to be outside the acceptance criteria, then a lot of up to 280 items can be accepted as being from a population with at least 96 percent of the items meeting the criteria. Restating this in terms of sampling in Indianapolis, if 13 (rounded down to 12 to fit a monthly schedule) samples are taken from a moderately industrial discharge during a one-year, 260-working day period, and no more than one exceeds the discharge limit, then the discharge meets the criteria more than 96 percent of the time. Thus, approximately 12 samples should be taken per year to assure that 96 percent of daily discharges are acceptable. This amounts to one sample per month, for all moderately large industries.

In the case of smaller industries, it is not necessary to be as sure of discharge acceptability as for larger ones, and because sampling costs can become a significant part of industrial operating costs, a reduced sampling schedule is recommended. Eight samples is the minimum number set out in Military Standard 105D for which one sample can be unacceptable while the lot or population is acceptable. It is very desirable from an administrative point of view to allow each industry one excursion without judging them to be in violation. Thus, at least eight samples must be taken during any sampling period. When comparing smaller and larger industries, it is appropriate to consider different "sampling periods". The year-to-year variations in the quantity of industrial waste loads from the largest contributors should be measured by means of weekly sampling, because seasonal or annual changes in production levels at major industrial plants can affect the concentration of a pollutant in the POTW influent. On the other hand, a small industry must radically change its process or size to affect the treatment plant, or change from the type of industry which doesn't discharge toxics to one which does. Such changes occur less frequently than production level changes; so for small plants, a sampling period of about 2 years is more appropriate than one year. Thus, once the nature of its discharge has been defined by an initial sampling effort, a small plant should be sampled only quarterly to check the character of its discharge. In this way, the sampling program makes use of data from past years to reduce the need for sampling in the current year. Therefore, small industries should be sampled four times per year.

As an alternative to the acceptance sampling procedure in Military Standard 105D, the Student t distribution statistical approach described above can be used to calculate the number of samples that need to be taken to estimate whether an industrial discharge exceeds the ordinance limit during any year. First, it is assumed that the daily composite pollutant concentrations in the discharge from any industry are normally distributed around an actual mean μ, with a standard deviation of . If this is the case than 99.7 percent of the daily composite concentrations will be less than μ + Z (99.7) * , where Z (99.7) = 2.75 (Ref. 1, page 69 and Table III, or Ref. 2, page 167 and Appendix 4). The value 99.7 percent is selected because it is equal to 364 * 100 ÷ 365 and thus represents the percent of each discharger's effluent values that must be in compliance if one daily value above the ordinance limit is allowed per year. As indicated before, JMM recommends that more than one sample per year above the limit be required before deciding that an industry is in violation of the ordinance.

Because both μ and are unknown, they must be estimated by calculating the sample mean $\bar{X}$ and sample standard deviation S. These statistical estimates can be expected to get closer to μ and as the number of analytical results used to calculate their increases. However, even with low number of data points, we can estimate the value below which 99.7 percent of the actual daily concentrations should lie, by calculating

$$\bar{X} + t\ (997) * S/(n1/2)$$

This estimates the upper boundary of the range in which 99.7 percent of the data points should fall, with 100-99.7 = 0.3 percent of the values above the boundary (the 99.7 percent maximum). The boundary can also be calculated to be

$$\bar{X} + Z(.997) * S/(n1/2)$$

but this applies only for large n, in which case the Z statistic approaches the t statistic. The table below lists t and Z values for several values of n, the number of samples per year.

COMPARISON OF t AND Z

Number of Samples (n)	t(.995)	Z(.995)	t/Z
3	5.84	2.58	2.27
4	4.6	2.58	1.78
8	3.36	2.58	1.30
12	3.06	2.58	1.19
24	2.80	2.58	1.09
29	2.76	2.58	1.07
00	2.58	2.58	1.00

Note that t(0.995) is used rather than t(0.997) simply because values for the former are available in tabulated form as a function of n.

It is preferable to use the Z statistic to calculate the 99.7 percent maximum for each industry in order to apply the same interval limitation to each industry no matter how many samples are taken. This avoids a situation in which a small company sampled four times per year is expected to have low enough that $\bar{X}$ + 4.6 S/ n is less than the ordinance limit, while a frequently sampled industry would be expected to have $\bar{X}$ + 2.58 * S/ n below the limit. By using the Z statistic, the requirement that $\bar{X}$ + 2.58 * S/ n is applied to all industries. However, the above tabular comparison of t and Z provides a means of juding the accuracy of this estimate of the 99.7 percent maximum, in that

- 4 samples correspond to t = Z $\pm$80%
- 12 samples correspond to t + Z $\pm$20%, and
- 48 samples correspond to t + Z $\pm$5%

The ±80 percent level of accuracy is applied to the smallest companies, the ±20 percent to the medium-sized companies, and the ±5 percent level to the largest companies.

In order to apply the above sampling frequency guidelines to industries in Indianapolis, the terms "significant load", "moderately large" and "small" must be defined as they pertain to industries. A "significant" portion of the POTW load is taken to be at least 1 percent of the existing load for any particular pollutant. The presence or absence of any industrial discharge smaller than 1 percent could not be detected by means of POTW influent metering technology, which is accurate to no better than ±1 percent. Industries can be considered moderately sized but worthy of monitoring if their discharge, when combined with the discharge from other similarly sized industries, contributes a measurable portion of the POTW load. In Indianapolis, if the estimated or measured industrial pollutant loads are summed up from all industries with discharges less than 0.1 percent of the total industrial load, the result is less than 1 percent of the total load.

The 1 percent and 0.1 percent loading size criteria used to separate the large, medium, and small dischargers are correlated with appropriate sample frequencies on Table 3-5. In addition, Table 3-6 lists the actual lb/day pollutant quantities corresponding to the 1 percent and 0.1 percent criteria. The resulting Industrial Sampling Groups on Table 3-5 represent a guide for assigning sampling programs to individual industries. It is recognized that the criteria are arbitrary to an extent. For example, the 1 percent cutoff might reasonably be adjusted to 0.5 or 2 percent, but not up to 10 percent. Therefore, some leeway exists to allow the Industrial Surveillance branch personnel to adjust monitoring programs to fit particular industries. Nevertheless, the sampling frequency chart in Table 3-5 is assumed to be a good representation of the normal or average frequency on which cost estimates and equipment purchase recommendations can be based.

Figure 3-1 illustrates the application of the 0.1 and 1 percent cutoffs to actual Indianapolis industries which discharge copper. The chart plots copper concentration against discharge flow for each industry reporting copper above the 200 μg/l background concentration on the Industrial Waste Survey. The load for each industry is the product of concentration and flow, multiplied by appropriate unit conversion factors, and is noted on the plot by each data point. Curves are drawn to represent the 0.1 and 1 percent AWT load lines, and horizontal lines represent the 8.0 mg/l proposed ordinance limit and the 2.7 mg/l metalplater categorical limit. It can be seen that only one industry is expected to be above the proposed copper discharge limit, while three are above the 1 percent cutoff line.

To evaluate the possible effect on the number of industries in different monitoring program groups, a normalized log-log plot was prepared of all process dischargers which reported pollutant concentrations on the Industrial Waste Survey. Figure 3-2 presents this plot. The use of a log-log scale enabled widely varying concentration data to be plotted together on the same scale, and

TABLE 3-5

INDIANAPOLIS PRETREATMENT
INDUSTRIAL GROUPS FOR DETERMINING SAMPLING FREQUENCY

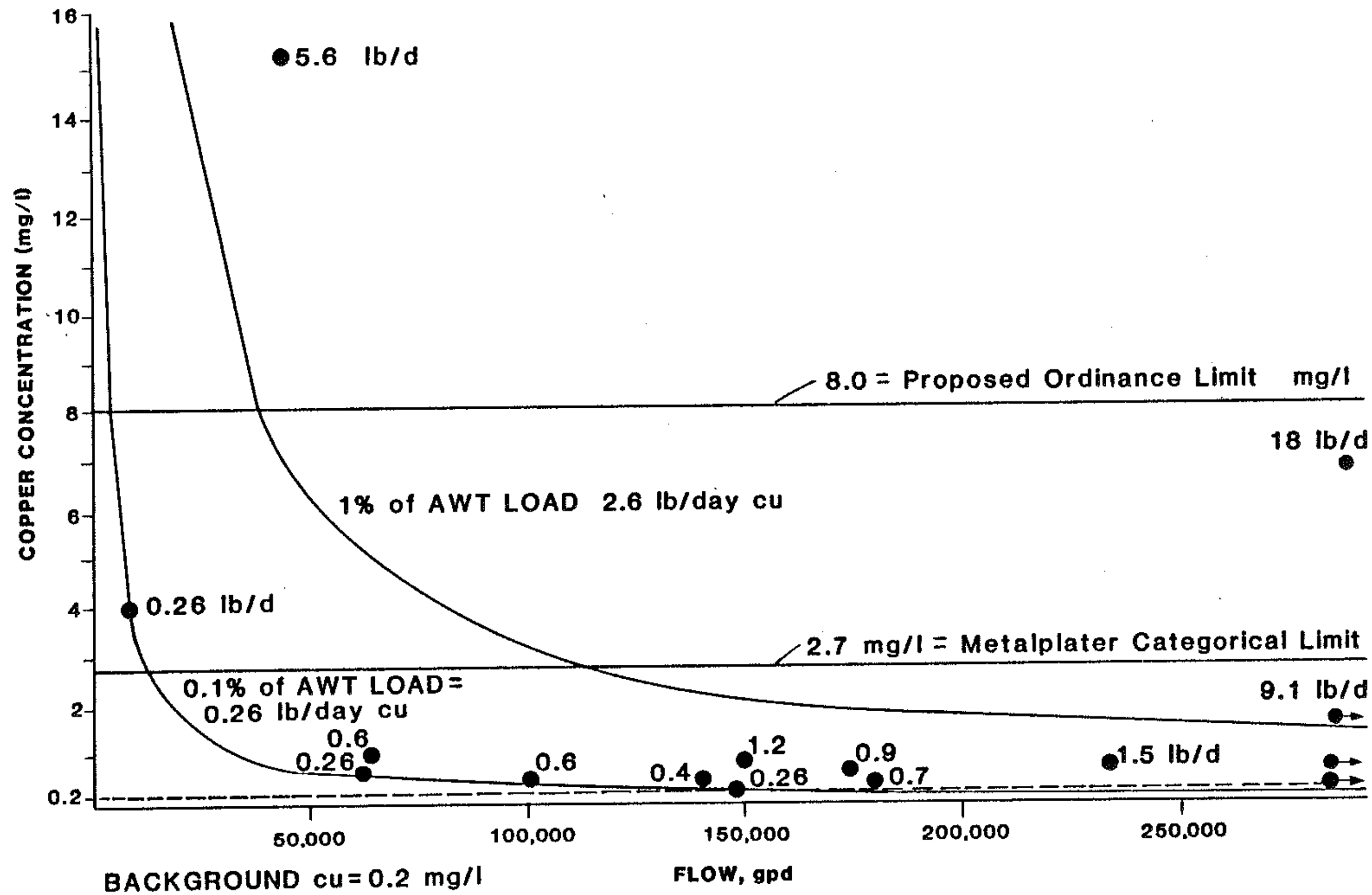
Group Number and Name	Criteria	Sampling Frequency
1. High Load	Discharges more than 1% of AWT influent load of an industrial pollutant, or discharges a conventional pollutant at more than 1% of AWT influent load and concentration over the surcharge concentration.	48 composites per year 1 grab per day (pH)
2. Moderate Load	Discharges more than 0.1% of AWT influent load of an industrial pollutant, or discharges a conventional pollutant over the surcharge concentration, (not in Group 1).	1 composite per month
3. Small Process Discharger	Discharges process wastewater (not in Group 1 or 2).	1 composite per quarter
4. Non-Process Discharger	Discharges only non-process sanitary wastewater.	Inspect every five years with possible grab sample.

TABLE 3-6

INDUSTRIAL POLLUTANT LOAD CRITERIA FOR SAMPLING FREQUENCY

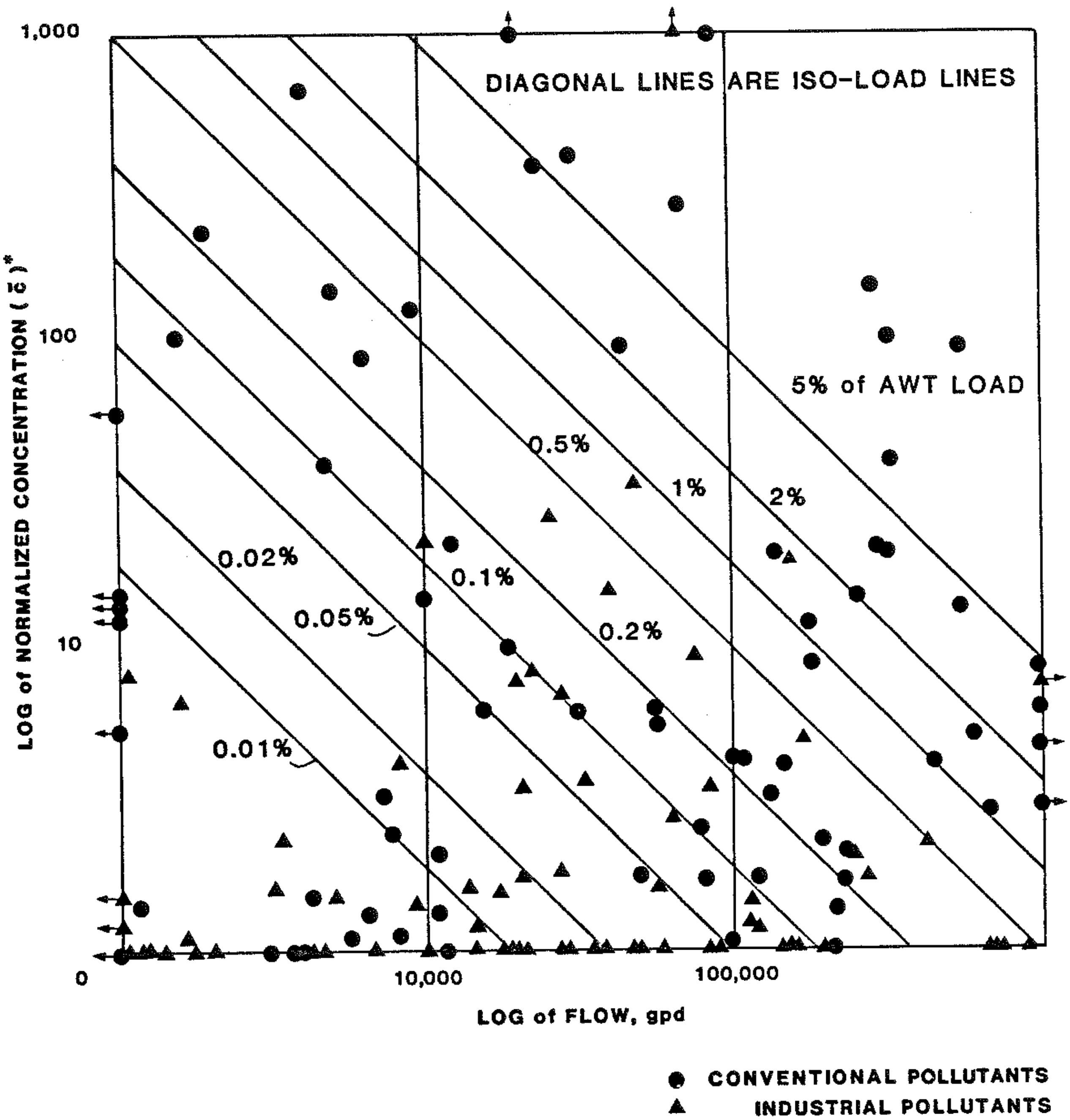
Pollutant	1 Percent Combined AWT Influent Load Criteria (lb/day)	1 Percent Combined AWT Influent Load Criteria (kg/d)	0.1 Percent Combined AWT Influent Load Criteria (lb/day)	0.1 Percent Combined AWT Influent Load Criteria (kg/d)
Arsenic	0.6	0.27	.06	0.03
Cadmium	0.1	0.045	0.02 (a)	0.01
Chrome (T)	1.5	0.68	0.15	0.07
Copper	2.5	1.16	0.26	0.12
Cyanide	2.7	1.23	0.27	0.12
Lead	4.4	2.00	0.44	0.2
Mercury	0.02	0.01	0.02	0.01
Nickel	1.5	0.68	0.15	0.07
Silver	0.04	0.02	0.02	0.01
Zinc	7.8	3.55	0.78	0.36
Phenol	2.7	1.23	0.27	0.12
BOD	3,400.0	1,545	--	
TSS	4,600.0	2,090	--	
NH_3-N	220.0	100	--	
O&G	894.0	406	--	

(a) The minimum load cutoff criteria is set to 0.01 kg/day = 0.02 lb/day, because of the limits on analytical accuracy.



PLOT OF INDUSTRIAL DISCHARGE CONCENTRATION VS FLOW FOR COPPER

FIGURE 3-1



*Normalized concentration is the highest concentration for each industry that results from dividing each industrial pollutant concentrations for that industry by the AWT influent concentration for that pollutant.

INDIANAPOLIS PRETREATMENT

LOG-LOG PLOT OF NORMALIZED CONCENTRATION VS FLOW

FIGURE 3-2

changed the shape of the 0.1 and 1 percent cutoffs from asymptotic curves to straight lines. The data for all pollutants was normalized by dividing each concentration by the average AWT influent value for that pollutant. For example, all copper values were divided by 163 μg/l, while all cadmium values were divided by 6 μg/l. One point is plotted on the graph for each industry, equal to the highest normalized concentration for any pollutant for that industry. For example, if an industry discharged copper at 500 μg/l and cadmium at 60 μg/l, it would be plotted with the normalized cadmium concentration of 101, because this is higher than the normalized copper concentration of 3. After plotting a point for each industry, a series of candidate cutoff lines ranging between 0.01 percent and 5 percent of AWT load were plotted. By inspection of the graph, it can be seen that there are no groups of similar industries that are divided by the 0.1 or 1 percent cutoffs, and that no other candidate cutoffs result in a more reasonable or manageable grouping. On the basis of this graph, it is therefore concluded that the 0.1 and 1 percent cutoffs are reasonable and workable grouping criteria for organizing Indianapolis industries for monitoring purposes.

Small industries that probably do not discharge process wastewaters should be sampled or inspected periodically to be sure that their wastewater contains only conventional pollutants. All samples taken should be grabs, since diurnal or shift changes should not affect the waste character. The sampling schedule would be generated from the industrial user list of non-process dischargers by sorting industry numbers in a random sequence. Each industry would be sampled once in 5 years.

Several options for grouping industries according to criteria other than pollutant mass loadings were investigated for Indianapolis. In particular, it was suggested that discharge flow alone should be a criteria, because of the potential for a high flow industry to discharge a significant mass loading by increasing the concentration of a pollutant by a small amount. For example, an industry discharging more than 500,000 gpd could impact the AWT influent load if the copper load changed from 100 μg/l (background domestic sewage concentration) to 800 μg/l, which is only 10 percent of the discharge standard for copper. However, when the Indianapolis industries with high flow and low industrial pollutant concentrations were counted and specifically characterized, it was found that they were very few in number, and they tended to be light industrial or commercial firms which discharged primarily sanitary wastewater but were classified by SIC code as being industrial. It was determined that it was not appropriate to require sampling based solely on flow, and this criteria was dropped from further consideration.

The other major option for grouping industries to determine sampling frequency would consider whether the discharge concentration for a particular company was close to a discharge limit concentration. Industries with high concentrations would be sampled frequently, regardless of size, on the premise that they are more likely to violate a permit limit than a company with a low concentration. This option is not recommended for two reasons. First, it is more important to the City to have an accurate idea of the discharge from a company large enough to impact the AWT than to be able to police small dischargers enough to catch every permit violation. A long list on small enforcement actions is not as important as a properly operating AWT. The second reason that this option is not recommended is that any industry with a concentration close to a permit limit will be sampled frequently under the recommended mass-based system, unless the flow is very small. For example, if an industry discharges close to 8 mg/l copper (the recommended standard), it will be above the 1 percent loading criteria for copper with only a 40,000 gpd flow, and above the 0.1 percent criteria with a flow of only 4,000 gpd. These flows correspond to 0.1 and 0.01 percent of the industrial flow in Indianapolis (approximately 30 to 40 mgd), and are therefore small compared to the 200,000 - 2,000,000 gpd discharges of larger industries. Therefore, industries will tend to be included in a high frequency sampling group because of loading even before they would be included because of high concentration.

It is of course that any industry found to be discharging above a permit limit would be sampled frequently as part of enforcement activities, but this sampling is not part of the routine monitoring under discussion here. Enforcement related sampling must be done in addition to routine compliance monitoring.

Sample Type. As discussed in Chapter 7 of the Task 4 Report (Pilot Plant Results, etc.), the industrial discharge limits recommended for Indianapolis are appropriate for enforcement as 24-hour composite samples are the most usefull sample type for monitoring. Composites are appropriate because of the equalization of wastewater in the sewers and POTW that tends to dilute any short term discharge into about 24 hours of flow. Nevertheless, grab samples can be used to economically identify problem dischargers or rapidly characterize new ones. A high concentration in a grab sample is an indication that additional composite sampling is in order while low value indicates that only routine monitoring should be done, per Table 3-5. Grab samples are the appropriate type for pH monitoring, and are somtimes best for monitoring cyanide and oil and grease, because these materials tend to be under-reported in composite samples. Cyanide tends to react and disappear during the 24-hour sampling period, and oil and grease float and adhere to the sides of hourly sample bottles.

Flow compositing of samples should not be necessary except in cases in which major flow changes occur from shift to shift, or from hour to hour, accompanied by large concentration changes. If the Sewer Use Ordinance is written to limit the concentration in "24-hour composite samples," there should be no difficulty in enforcing ordinance limits on the basis on non-flow composited samples. However, it is recommended that the City start to utilize flow composited samples for any industry which tends toward chronic violation of discharge limits, simply to avoid the issue of whether the samples require flow compositing. As the number of chronic violators (probably less than 10) should be far less than the number of industries overall, the extra expense and effort to collect flow composited samples will not have a discernable impact on ISO staffing. Flow compositing equipment will be required, as seen in Chapter 4 of this report.

One of the options open to the ISB is the collection of sets of three to sequential flow composited 24-hour samples on industrial discharges. Several other cities, notably Chicago, have adopted this procedure. It is suggested that the ISB utilize this procedure as a technically equivalent alternative to the collection of three to seven isolated independent 24-hour samples. The cost for a sequence of flow composited samples should be approximately the same as for the same number of isolated 24-hour composites, because while the use of flow metering equipment complicates sample collection, the fact that the equipment need only be set up once per set of samples reduces labor requirements. From the point of view of the quality of the samples, an annual multi-day flow compositing produces a sample accurately representative of conditions at one point in time, while isolated composites provide a set of samples more representative of discharge conditions over the course of the year. It is recommended that the ISB make use of both of these sampling techniques, and compare and combine the resulting data to characterize each industrial discharge.

Selection of Analysis Type. Industrial monitoring samples taken need not always be analyzed for all of the pollutants regulated in the industrial waste ordinance. If an industry consistently demonstrates that it discharges insignificant concentrations of one pollutant, the frequency of analysis can be reduced although samples will need to be taken for analysis for other pollutants. Although special samples may be taken and analyzed for toxic organics and other material not specifically regulated in the Industrial Waste Ordinance, such analyses generally require specific sampling and preservation techniques, and so are not normally run on the routine industrial monitoring samples.

Two options are presented in this report for selecting which analyses to run on each sample. The following general guidelines will be used to determine which analyses are run on each sample for analysis option I:

- At least four samples per year will be analyzed for all regulated pollutants. The results from these analyses will be used to determine the analyses to be run on all samples the following year.

- All samples from a particular industrial discharge will be analyzed for any regulated toxic pollutants found at or above the background concentration cutoff limit in more than one sample from the previous year. Table 3-6a lists the "Background cutoff" limits, which are set in general to twice the typical background concentration for any pollutant in Indianapolis domestic sewage.

- All samples from an industry will be analyzed for all surchargeable conventional pollutants (BOD, TSS) if more than one sample from the previous year showed a concentration above the surcharge concentration.

- The list of analyses to be run on routine samples from each industry will be reviewed annually, and revised as needed.

TABLE 3-6a

BACKGROUND CUTOFF VALUES (1)
FOR DETERMINING WHETHER
EACH INDUSTRY SHOULD BE PERMITTED FOR A
PARTICULAR POLLUTANT

Pollutant	Cutoff
BOD	250 mg/l
TSS	300 mg/l
NH_3-N	20 mg/l
Oil and Grease	50 mg/l
Arsenic (As)	50 µg/l
Cadmium (Cd)	10 µg/l
Chromium (Cr) (T)	100 µg/l
Copper (Cu) (T)	200 µg/l
Cyanide	50 µg/l
Lead (Pb)	50 µg/l
Mercury (Hg)	1 µg/l
Nickel (Ni)	50 µg/l
Silver (Ag)	50 µg/l
Zinc (Zn)	400 µg/l
Phenol	25 µg/l

(1) Note that the above listed cutoff values are generally set to two times the measured Indianapolis background concentration for domestic sewage or to the surcharge limit for conventional pollutants.

Table 3-7a lists the number of analyses of different types that would be run on the samples collected from each Industry Group according to option I. The groups are subdivided according to the type of pollutants that need to be analyzed. This table is formulated using actual discharger data from city files and the Industrial Survey. The table is intended to provide the basis for planning analytical budgets and schedules.

In general, analysis selection option I is based on the assumption that once the money to collect a sample has been spent, the marginal extra cost to run analyses is relatively low. Thus, if an industry is self-monitoring by taking 48 samples per year and analyzing for chrome because its chrome discharge is more than one percent of the AWT load, it should also analyze all 48 samples for copper if this pollutant is discharged above background concentration, even though the discharged copper load is less than one percent of the AWT load.

Analysis selection option II is designed to minimize the analytical cost while still collecting the data required for calculation of average discharge loads, for compliance monitoring, and for industry characterization. Under this option, samples would be analyzed according to the following general guidelines.

- At least four samples per year will be analyzed for all regulated pollutants. The results from these analyses will determine whether any pollutants should be added to an industry's permit because they are present above background or surcharge concentrations.

- 48 samples per year will be analyzed for any pollutant discharged at a rate more than one percent of the AWT influent load (if above background or surcharge concentration).

- 12 samples per year will be analyzed for any industrial pollutant discharged at more than 0.1 percent of the AWT influent load at above background concentration.

- 12 samples per year will be analyzed for any conventional pollutant discharged above surcharge concentration.

Table 3-7b lists the analyses of different types that would be run under option II on the samples from each industry group. Because option II represents the most economical approach to collection of the data necessary for the pretreatment program, it is recommended over option I. Option II will require a more complex (and administratively costly) monitoring program for the largest industries, but should more than cover this increased cost through reduced analytical costs.

The selection of compounds analyzed on a regular basis for a particular industrial wastewater sample is determined annually according to the above guidelines. At the discretion of ISB, a compound may be deleted from an industry's routine monitoring list if it has shown a good record of control. In deleting a compound from an industry's routine monitoring list, consideration should be given to the number of samples analyzed during the record period, the potential impact the

TABLE 3-7(a)

**INDIANAPOLIS PRETREATMENT
INDUSTRIAL GROUPINGS FOR DETERMINING
ANALYTICAL PROGRAM
(Analysis Selection Option I)**

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
1.A: High Industrial Load	Discharges more than 1% of AWT load for an industrial pollutant. (1)	4 samples/year analyzed for 14 requlated pollutants. 48 samples/year analyzed for permitted pollutants. 360 samples/year for pH.	20
1.B: High Industrial and Surcharged Load	Discharges more than 1% of AWT load for an industrial pollutant and discharges a surcharge pollutant (2) above the surcharge limit.	4 samples/year analyzed for 14 regulated pollutants. 48 samples/year analyzed for permitted pollutants. 360 samples/year for pH.	12
1.C: High Surcharged Load	Discharges more than 1% of AWT load for a surcharged pollutant above surcharge concentration.	4 samples/year analyzed for 14 regulated pollutants. 48 samples/year analyzed for permitted pollutants. 360 samples/year for pH.	2

TABLE 3-7(a) (Continued)

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
2.A: Moderate Industrial Load	Discharges more than 0.1% of AWT load of an industrial pollutant (not in Group 1).	4 samples/year analysed for 14 regulated pollutants. 12 samples/year analyzed for permitted industrial pollutants.	13
2.B: Moderate Industrial and Surcharged Load	Discharges more than 0.1% of AWT load of an industrial pollutant and discharges a surcharged pollutant above surcharge limit (not in Group 1).	4 samples/year analyzed for 14 regulated pollutants. 12 samples/year for permitted conv. and ind. pollutants.	7
2.C: Moderate Surcharged Load	Discharges a surcharged pollutant above surcharge limit (not in Group 1).	4 samples/year analyzed for 14 regulated pollutants. 12 samples/year analyzed for permitted conventional pollutants.	52

TABLE 3-7(a) (Continued)

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
3. Small Process Discharger	Discharges industrial process wastewater (not in Group 1 or 2).	4 samples/year analyzed for 14 regulated pollutants.	140
4. Non-Process Discharger	Discharges only Sanitary non-process process wastewater	No more than 1 grab every 5 years analyzed for 14 regulated industrial pollutants.	540

Notes:

(1) Industrial Pollutants include Oil and Grease, Cyanide, Phenols, and Metals.

(2) Surcharged Pollutant Surcharge Limits are 250 mg/l BOD, 300 mg/l TSS, and 20 mg/l NH_3-N.

(3) While there are 238 industries in Groups 1, 2, and 3, eight of these have two separate discharges that must be monitored, so there are 246 process discharges in Groups 1, 2, and 3.

TABLE 3-7(b)

INDIANAPOLIS PRETREATMENT
INDUSTRIAL GROUPINGS FOR DETERMINING
ANALYTICAL PROGRAM
(Analysis Selection Option II)

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
1.A: High Industrial Load	Discharges more than 1% of AWT load for an industrial pollutant. (1)	4 samples/year analyzed for 14 requlated pollutants. 48 samples/year analyzed for ind. pollutants above 1% of AWT load. 12 samples/year analyzed for ind. pollutants above 0.1% of AWT load, or pollutants above surcharge limits. 360 samples/year for pH.	20
1.B: High Industrial and Surcharged Load	Discharges more than 1% of AWT load for an industrial pollutant and discharges a surcharge pollutant (2) above the surcharge limit.	4 samples/year analyzed for 14 regulated pollutants. 48 samples/year analyzed for ind. pollutants above 1% of AWT load or surcharged pollutants above 1% of AWT load.	12

TABLE 3-7(b) (Continued)

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
1.B: (Continued)		12 samples/year analyzed for ind. pollutants above 0.1% of AWT load or pollutants above surcharge limits. 360 samples/year for pH.	
1.C: High Surcharged Load	Discharges more than 1% of AWT load for a surcharged pollutant above surcharge concentration.	4 samples/year analyzed for 14 regulated pollutants. 48 samples/year analyzed for surcharged pollutants above 1% of AWT load. 12 samples/year analyzed for ind. pollutants above 0.1% of AWT load or pollutants above surcharge limits. 360 samples/year for pH.	2
2.A: Moderate Industrial Load	Discharges more than 0.1% of AWT load of an industrial pollutant (not in Group 1).	4 samples/year analysed for 14 regulated pollutants. 12 samples/year analyzed for ind. pollutants above 0.1% of AWT load.	13
2.B: Moderate Industrial and Surcharged Load	Discharges more than 0.1% of AWT load of an industrial pollutant	4 samples/year analyzed for 14 regulated pollutants.	7

TABLE 3-7(b) (Continued)

Group Number and Name	Criteria	Analytical Program	Count of Discharges (3) in Group
2.B: (Continued)	and discharges a surcharged pollutant above surcharge limit (not in Group 1).	12 samples/year for permitted conv. and ind. pollutants above 0.1% of AWT load, or for pollutants above surcharge limits.	
2.C: Moderate Surcharged Load	Discharges a surcharged pollutant above surcharge limit (not in Group 1).	4 samples/year analyzed for 14 regulated pollutants. 12 samples/year analyzed for pollutants above surcharge limits.	52
3. Small Process Discharger	Discharges industrial process wastewater (not in Group 1 or 2).	4 samples/year analyzed for 14 regulated pollutants.	140
4. Non-Process Discharger	Discharges only Sanitary non-process process wastewater	No more than 1 grab every 5 years analyzed for 14 regulated industrial pollutants.	540

Notes:

(1) Industrial Pollutants include Oil and Grease, Cyanide, Phenols, and Metals.
(2) Surcharged Pollutant Surcharge Limits are 250 mg/l BOD, 300 mg/l TSS, and 20 mg/l NH_3-N.
(3) While there are 238 industries in Groups 1, 2, and 3, eight of these have two separate discharges that must be monitored, so there are 246 process discharges in Groups 1, 2, and 3.

industry would have on the treatment system if it were out of compliance, and the concentration of the compound under consideration at the POTW. Industries that have a good record, based on a large number of samples, should have their routine monitoring list revised accordingly. Industries with a minimal sample record require further consideration into such areas as the nature of the process and the level of control and treatment of regulated compounds, the magnitude and impact of an out-of-compliance discharge from the industry would have on the treatment system, and the concentration of the regulated compound at the POTW.

In addition to the monitoring of regulated and surchargeable pollutants by industry, it is recommended that industry also measure the pH of all samples. Abnormal pH readings are good indicators of potential problems and can indicate the need for additional analyses. As this test is relatively simple and inexpensive to perform, it should be measured and reported on all samples collected by industry.

POTW and interceptor samples should be analyzed for all regulated compounds. The frequency of analysis on POTW samples should be every two weeks. Other samples may be analyzed on an as-needed basis for slug discharges or other unusual conditions. The POTW influent samples should be given gas chromatograph scans for organic (penta-chlorophenol and para-chloro-meta-cresol) compounds. Of particular interest are volatile organics and phenolic compounds. While specific limitations are not placed on such compounds in the Industrial Waste Ordinance, these compounds can cause operational problems if present in sufficient quantity. Volatile compounds and phenolics were identified as being of interest during the waste characterization and pilot plant operations as they were found throughout the pretreatment sampling program. These compounds, particularly the phenolics, were also associated with pilot plant and treatment plant upsets during that period.

Pesticides, PCB's, and base-neutral-acid extractable compounds were not found on a regular basis or in significant enough quantities to warrant their continual monitoring in the POTW influent. Periodic checks on these compounds should, however, be performed to assure that they are not present in the future. Analysis for these compounds should be performed at least two times per year. The presence of halogenated compounds, which includes most pesticides and PCB's, could be checked with a total organic chlorine test (TOX). The test does not distinguish groups of compounds, but can give a relatively quick and inexpensive test for all halogenated organics. Abnormally high TOX values would indicate the need for a more extensive analysis with a gas chromatograph. The TOX test could be performed every two weeks, as a check on the presence of pesticides and PCB's.

Phenolics could also be tested every two weeks. The test would give an indication of abnormally high concentrations of phenols. Further tests with a gas chromatograph could then be performed to identify specific phenol compounds.

The basic premise for selecting the types of compounds being analyzed in the POTW is to get an extensive view of all compounds which have been found in influent, or which could cause substantial harm if present. The analysis of regulated compounds, volatile organics, phenolics, and other compounds discussed above would provide sufficient information to evaluate harmful industrial activities.

The analyses of POTW and interceptor samples for all priority pollutants and additional industrial chemical possibly present is an expensive and time consuming undertaking. A less costly and time consuming approach would be the use of tests which measure groups of compounds rather than analyzing for specific compounds. Such tests can be used as an indicator of industrial discharges and can direct the analysist's work to a more detailed analysis when abnormal readings or conditions occur.

There are two tests in particular which have been suggested as indicators of industrial wastes at Indianapolis, namely phenols and total organic chlorine (TOX). The phenols test (4AAP method) could be useful due to the number of phenolic compounds detected in the Indianapolis wastewater and treatment plant upsets associated with them during the operation of the pretreatment pilot plant. It must be recognized that the phenols test measures only some of these phenolics and so would be a relatively imperfect indicator test. The TOX test is useful as an indicator of chlorinated organic compounds. Many common industrial solvents and pesticides would be detected with this test. Typical influent wastewater values for these tests measured during the pretreatment pilot plant study are 0.17 mg/l for phenols and 0.20 for TOX.

Monitoring Entity and Data Verification. Industrial monitoring samples can be taken and analyzed by the City of Indianapolis, by the industries themselves, or by independent laboratories. The samples can even be taken by one entity and analyzed by another. The question of "who monitors" is decided partly based on economics and partly based on legal, quality control and administrative considerations.

A program in which industries perform all monitoring is not practical because the City needs to take some samples to verify the accuracy of the data. Likewise, large industries tend to take and analyze samples to check City monitoring results. The total cost to a large industry to monitor their own sewer discharge may be significantly less than if the City performs the monitoring function and passes all costs back to the industry together with handling, administration and other overhead charges. On the other hand small industries cannot afford to maintain trained sampling and analytical staff, who would be used infrequently. The use of outside, certified laboratories can aid industries who do not wish to maintain their own staff, and can sometimes help to establish that the data were generated by an objective, non-partisan entity. However, the City (as well as some large industries) can generally cut costs by performing work in-house. On the basis of this discussion, the recommended monitoring program should take advantage of all three types of monitoring entities.

To verify analytical accuracy, at least 20 percent of the samples taken should be by the City, and up to 80 percent by industry (either using in-house or outside certified laboratory personnel). In addition, the City should take about 12 samples per sampling period to verify compliance per the discussion on pages 3-17 and 3-18. For the largest industries, the number of compliance samples is set to 10 to match the 20 percent criteria. For the small dischargers, the sampling period is set to two years, requiring four samples per year. For medium-size industries, the City sample count for compliance monitoring is set to 12. Table 3-8 and Table 3-9 present two alternatives (Monitoring Entity, Options A and B) for balancing the load between monitoring entities, and Tables 3-10, 3-11, 3-12, and 3-13 list the numbers of analyses that would be required by the City or by industry for each monitoring entity option and for each analysis selection option. The tables include 50 composite and 50 grab samples taken and analyzed by the City for special problem situations.

JMM recommends implementation of Monitoring Entity Option A, because it provides the City with adequate verification of analytical accuracy while at the same time placing most of the responsibility for frequent routine monitoring on industry. Thus, considering the recommendation made on page 3-30 for analysis selection Option II, Table 3-11 lists the analytical load for the overall recommended option (II-A).

One of the important responsibilities of the ISB is to coordinate verification sampling with industries' self-monitoring sampling. Because of the instantaneous variability of a waste stream, it is imperative that some sample verification be conducted on split sample. The easiest way to assure this is by splitting a sample between the industry and ISB. Because industry is required to collect the samples for self-monitoring reports, the industry could also collect the sample for self-monitoring verification. The ISB would would simply pick-up the sample from industry whenever analysis were to be run. If the ISB normally collects compliance samples, they could leave split samples with the industry. There are two options for scheduling self-monitoring verifications:

- Predetermine schedule with industry for split sampling
- Unannounced sample collection schedule

Under the first option, the schedule for self-monitoring verification is predetermined in advance. Industry is aware of sample dates and will collect sufficient sample for analysis by the City. The advantage of this option is that it minimizes industries sample handling and holding. The disadvantage of this option is that there may be some bias in the collected samples, as industry may be more cautious in their operations or deviate from their normal practices during such sampling periods.

The second option requires that industry collect and hold daily or weekly samples for a predetermined time. The ISB will use an internal schedule to obtain the sample from industry. If ISB does not collect the sample within the predetermined time, industry may dispose of the sample. The advantage of this

TABLE 3-8

INDIANAPOLIS PRETREATMENT

MONITORING ENTITY
ALTERNATIVES
(Analysis Selection Option I)

	Monitoring Option A	Monitoring Option B
Option Name:	Industry self-monitoring with City verification.	City monitoring with industry verification.
Option Description:	Large industries self-monitor by taking and analyzing up to 80% of the samples required, while the City analyzes at least 20% of the samples per year for verification.	City monitors by taking and analyzing between 20% and 80% of required samples while industries may analyze up to 20% of the samples for verification.
	All pH grabs will be taken by industry.	All pH grabs will be taken by industry.
	A total of 100 special problem/slug samples to be taken by City per year.	A total of 100 special problem/slug samples to be taken by City per year.

Annual Count of Samples per Industry by:	Option A: City	Option A: Industry	Option B: City	Option B: Industry
For Groups with:				
4 Composites per Month	10 (P) 4 (R)	48 (R)	48 (P) 4 (R)	10 (P)
1 Grab per day	0	360 (pH)	0	360 (pH)
1 Composite per Month	12 (P) 4 (R)	0	12 (P) 4 (R)	0
1 Composites per Quarter	4 (R)	0	4 (R)	0
1 Grab in 5 Years	0.2 (R)	0	0.2 (R)	0

Note : R = analyzed for 14 regulated pollutants.
P = analyzed for permitted pollutants (above background).

TABLE 3-9

INDIANAPOLIS PRETREATMENT

MONITORING ENTITY ALTERNATIVES (Analysis Selection Option II)

	Monitoring Option A	Monitoring Option B
Option Name:	Industry self-monitoring with City verification.	City monitoring with industry verification.
Option Description:	Large industries self-monitor by taking and analyzing up to 80% of the samples required, while the City analyzes at least 20% of the samples per year for verification.	City monitors by taking and analyzing between 20% and 80% of required samples while industries may analyze up to 20% of the samples for verification.
	All pH grabs will be taken by industry.	All pH grabs will be taken by industry.
	A total of 100 special problem/slug samples to be taken by City per year.	A total of 100 special problem/slug samples to be taken by City per year.

Annual Count of Samples per Industry by:	Option A City	Option A Industry	Option B City	Option B Industry
For Groups with:				
4 Composites per Month	10 (H) 4 (R)	48 (H) 12 (M)	48 (H) 12 (R) 4 (R)	10 (H) 2 (M)
1 Grab per day	0	360 (pH)	0	360 (pH)
1 Composite per Month	4 (R)	12 (M)	12 (M) 4 (R)	2 (M)
1 Composites per Quarter	4 (R)	0	4 (R)	0
1 Grab in 5 Years	0.2 (R)	0	0.2 (R)	0

Note : H = Analyzed for high load pollutants (above 1% AWT load)
M = Analyzed for medium load pollutants (above 0.1% AWT load or above surcharge conc.).
R = Analyzed for 14 regulated pollutants.

TABLE 3-10

INDIANAPOLIS PRETREATMENT ESTIMATED ANNUAL COUNT OF SAMPLES AND ANALYSES

Assuming Self-Monitoring for Permit Compliance with City Monitoring for Permit Revision (Monitoring Entity Option A) (Analysis Selection Option I)

	City Monitoring	Industrial Self-Monitoring
Composite Samples/Year	1,814*	1,632
Grab Samples/Year	158*	12,240
pH (all samples)	1,972	13,872
BOD_5	1,602	528
TSS	1,532	480
NH_3-N	1,262	432
Oil & Grease	1,326	432
Arsenic	1,198	48
Cadmium	1,318	624
Chrome (T)	1,296	624
Chrome (VI	100	240
Copper	1,318	816
Cyanide (T)	1,346	720
Cyanide (A)	20	96
Lead	1,272	384
Mercury	1,226	144
Nickel	1,382	720
Zinc	1,344	768
Phenols	1,262	432
Total Metals	10,454	4,368
Total Phenols, CN, O&G	3,954	1,640

* Table includes 50 composites and 50 grab samples analyzed by the City for 14 regulated pollutants for special situations, enforcement, slugs, etc.

TABLE 3-11

INDIANAPOLIS PRETREATMENT
ESTIMATED ANNUAL COUNT OF SAMPLES AND ANALYSES

Assuming Self-Monitoring for Permit
Compliance with City Monitoring
for Permit Revision
(Monitoring Entity Option A)
(Analysis Selection Option II)

	City Monitoring	Industrial Self-Monitoring
Composite Samples/Year	1,238	2,496
Grab Samples/Year	158	12,240
pH (all samples)	1,396	13,872
BOD_5	1,228	900
TSS	1,210	672
NH_3-N	1,222	348
Oil & Grease	1,198	216
Arsenic	1,192	36
Cadmium	1,252	576
Chrome (T)	1,228	60
Chrome (VI)	100	348
Copper	1,216	348
Cyanide (T)	1,204	216
Cyanide (A)	20	48
Lead	1,198	96
Mercury	1,198	48
Nickel	1,222	468
Zinc	1,228	432
Phenols	1,216	264
Total Metals	9,834	2,736
Total Phenols, CN, O&G	3,638	744

TABLE 3-12

INDIANAPOLIS PRETREATMENT
ESTIMATED ANNUAL COUNT OF SAMPLES AND ANALYSES

Assuming Self-Monitoring for Permit
Compliance with City Monitoring
for Permit Revision
(Monitoring Entity Option B)
(Analysis Selection Option I)

	City Monitoring	Industrial Self-Monitoring
Composite Samples/Year	3,106	340
Grab Samples/Year	158	12,240
pH (all samples)	3,264	12,580
BOD_5	2,024	106
TSS	1,916	96
HN_3-N	1,608	86
Oil & Grease	1,672	86
Arsenic	1,236	10
Cadmium	1,817	125
Chrome (T)	1,795	125
Chrome (VI)	290	50
Copper	1,971	163
Cyanide (T)	1,922	144
Cyanide (A)	96	20
Lead	1,579	77
Mercury	1,341	29
Nickel	1,958	144
Zinc	1,958	154
Phenols	1,608	86
Total Metals	13,945	877
Total Phenol, CN, O&G	5,298	336

TABLE 3-13

INDIANAPOLIS PRETREATMENT
ESTIMATED ANNUAL COUNT OF SAMPLES AND ANALYSES

Assuming Self-Monitoring for Permit
Compliance with City Monitoring
for Permit Revision
(Monitoring Entity Option B)
(Analysis Selection Option II)

	City Monitoring	Industrial Self-Monitoring
Composite Samples/Year	3,106	340
Grab Samples/Year	158	12,240
pH (all samples)	3,264	12,580
BOD_5	1,864	162
TSS	1,676	118
NH_3-N	1,484	68
Oil & Grease	1,348	38
Arsenic	1,216	6
Cadmium	1,696	116
Chrome (T)	1,536	80
Chrome (VI)	70	12
Copper	1,472	66
Cyanide (T)	1,360	40
Cyanide (A)	58	10
Lead	1,268	18
Mercury	1,236	10
Nickel	1,564	88
Zinc	1,552	84
Phenols	1,416	52
Total Metals	11,610	480
Total Phenol, CN, O&G	4,182	140

method is that the sample will have less bias, in that industry is unaware of the schedule and should closely resemble the normal character of the waste. The disadvantage is the need for industry to collect and hold additional samples, and for ISB to collect the scheduled samples promptly.

The second method is recommended as it will achieve the desired result of verifying industries self-monitoring analyses and compliance with the Industrial Waste Ordinance. The recommended holding time for samples collected by industry is 24 hours. This will minimize the burden on industry for hold storage while providing sufficient time for the City to collect the sample. The City should plan to analyze split duplicates of about 10 percent of the self-monitoring samples, or between 4 and 5 samples.

The City should also check the sampling technique of each self-monitoring industry by requiring that the industry take and analyze 4 to 5 samples in parallel with City samples taken by ISB staff. This is accomplished simply by having the ISB staff visit the industry and collect 4 to 5 samples per year using a City-owned composite sampler on days when the industry is taking self-monitoring samples.

Sampling Procedures (Task 9.4)

General. Development of appropriate sampling procedures includes three main areas, namely: (i) sampling method, (ii) sample acquisition and care, and (iii) storage and shipment of samples. Each of the areas is discussed below.

Sampling Method. There are four major sampling methods generally applicable to industrial and priority pollutant sampling, namely:

1. Method 1: Custom-Automated-Stationary
2. Method 2: Semi-Automated-Portable
3. Method 3: Grab-Automated-Portable
4. Method 4: Grab

Method 1: Custom-Automated-Stationary requires three types of samplers, namely: (i) a custom built sampler for volatile organics sample analyses, (ii) a vacuum or parastaltic type sampler for mineral sample analyses, and (iii) a vacuum or parastaltic type sampler for metals sample analyses. The custom built organic sampler must be constructed such that those parts which are in contact with the liquid sample are made from glass or teflon to prevent absorption of organics into the sampler material. The sample container must be designed such that there is no "free head space" above the sample during the collecting period. This prevents the release of volatile organics. In addition, the sample must be kept refrigerated at all times. The vacuum or parastaltic type samplers employed for the mineral analyses and metal analyses are of the standard type commercially available (ie: Manning or ISCO, etc.).

The method sampling scheme assures the best sample integrity and will produce the greatest analytical accuracy. However, this type of sampling program requires the construction of an expensive custom built organic sampler, which is suspectible to high maintenance; the samplers must be stationary; and a skilled sampling technician is required. In general, this method produces the most reliable results, but also has the highest cost.

Method 2: Semi-Automated-Portable requires taking a grab sample for volatile organics, using three separate vacuum or parastaltic type samplers (Manning or ISCO, etc.) for taking non-volatile organic samples, general mineral samples, and samples for metals analysis. The volatile organics sample is taken in a grab mode such that the sample container is totally full to eliminate volitization into the head space above the sample in the sample container. The three separate vacuum or parastaltic type samplers are mounted adjacent to one another such that all samples are taken at the same time. If a primary flow measuring device is present, it is possible to sequency the three automated samplers to obtain a 24-hour flow proportional composite sample. Otherwise, these samplers can be set to take a composite sample with time. This type of system is portable and can be used in control manholes, at industrial discharges, or at collection system sampling points. However, in general, it requires the installation of three samplers in a single manhole. Alternately, a single sampler could be installed with the sample taken on three separate days. This type of sampling scheme provides a slightly lower level of accuracy than Method 1. The major loss of accuracy is in with the volatile organics fraction which is sampled only on a grab basis, rather than a 24-hour composite basis as in Method 1. This sample scheme is less expensive than Method 1, but is significantly higher in cost than Method 3 or Method 4.

Method 3: Grab-Automated-Portable requires the taking of the volatile organics fraction sample using grab sample techniques, as described above. The remaining samples for other organic constituents, general mineral analyses, and metal analyses, are collected in a single vacuum or parastaltic type sampler (i.e., Manning, ISCO, etc.) which is equipped to collect 24 samples. The sample perservative for each type of sample (ie, organics, minerals, metals, etc.) is placed in every fourth discrete sample bottle and the sampler set to take a sequential discrete sample over a given period of time. Since sufficient discrete sample bottles must be available for the entire sampling period, it is not possible to take an automatic flow proportional sample with this method. However, if a flow recording device is present to record flow, then it is possible to manually composite the discrete samples in flow proportional method. The advantages of this sample scheme are ease of installation, relatively low cost, and sample integrity. The disadvantages of this method are the manual compositing of samples according to flow, and the inability to collect more than six discreet samples in a 24-hour period.

Method 4: Grab involves the collecting of each type of sample (ie, volatile organics, non-volatile organics, minerals, heavy metals, etc.) by using a grab sample technique. The grab sample may be taken once during a 24-hour time period or at any time interval (i.e.: one sample every 4 hours for a 24-hour time period) which is convenient to sample personnel. The samples may be composited manually according to flow provided a flow recording device is present at the sampling station. (This composited sample is often referred to as a "hand compositied sample".) This method is probably the least cost of the four methods, however its reliability and accuracy is significantly dependant upon sampling personnel. If grab samples are to be taken over a 24-hour period, it is imperative that sampling personnel collect the grab samples at the prescribed time. Generally, such sampling procedures are suspect from a legal point of view.

Sample Acquisition and Care. A specific set of automated samplers should be dedicated to sample collection at manholes or sample ports. These samplers should be reserved for sampling within the collection system and at industrial discharges. The samplers should not be utilized for sampling at the wastewater treatment plant. A separate set of samplers should will be employed at the treatment facility. The following procedures apply to sample collection at manholes or sampling ports located at industrial discharges, sampling points within the collection system, or at any other similar type of sampling installation.

1. If site is in an area of automobile traffic, then park the sample collection vehicle to protect the site, set out traffic cones and barricades.

2. Remove the cover by prying loose with a pry bar and dragging the cover to the side with a hook. Do not lift the cover. (Lifting the cover could cause severe personal injury.)

3. Set up blower to ventilate air into the manhole. Do not reverse air flow direction and pull air out of manhole, since this will tend to ventilate the sewer line above and below the site.

4. Ventilate the site for at least ten minutes. Shut off blower and monitor air.

5. When manhole entry has been approved, strap on the full body harness and lower person into the work area with tripod and winch. Do not use manhole rings.

6. Turn blower back on and continue to monitor air while person is in the manhole.

7. Collect grab sample for volatile organics fraction analysis and place sample container in ice or refrigerated container.

8. If appropriate, install primary measuring device per manufacturer's instructions.

9. If primary measuring device is utilized, attach flow meter and sampler (if appropriate) to primary measuring device per manufacturer's instructions.

10. Check sampler bottles for correct preservative and proper sequence. Add ice to sampler center compartment to keep samples chilled during collection.

11. Calibrate and adjust all equipment as required and locate within manhole.

12. Clean the sample site as necessary, and replace manhole cover by dragging over hole with hook. Do not lift manhole cover.

The following procedures should be employed to manually composite samples collected by discreet samplers or where automated 24-hour flow proportioning is not possible.

1. Remove discrete sample containers from sampler base and group by preservative type and time of collection during the 24-hour period.

2. If the sampling interval was controlled by a flow meter, then pour equal amounts of each sample type into the specific sample container.

3. From the unpreserved sample bottles, remove a portion from each discrete sample bottle and add to the bottle for phenol analysis.

4. If the sampling interval was not controlled by a flow meter, then the discrete samples must be composited manually by comparing total flow to the flow during the four hour sample period. From this analysis, a calculation to determine the fraction of sample composited from each four-hour period is made. The amount of sample is then added to the shipping container.

5. Again, as in item 3 above, a portion of the unpreserved samples must be removed from the discrete sample bottles and added to a total phenol sample bottle.

The above sampling procedures should be implemented in such a way as to consider the individual characteristics of different pollutants. The standard sampling procedures in Table 3-14 are specifically designed for each of the listed industrial pollutants.

Storage and Shipment of Samples. The following procedures apply to samples in transit from sample collection to the City's laboratory or, in transit to a commercial laboratory.

1. All samples, especially those intended for volatile organics analyses and organics analyses must be stored in refrigerated conditions until shipped. (2°C)

TABLE 3-14

**INDIANAPOLIS PRETREATMENT
STANDARD SAMPLING PROCEDURES**

Pollutant	Procedure
Cyanide:	Fill the container to the neck. Do not rinse out the preservative which has been added. The samples should be kept on ice before shipping.
Heavy Metals:	One 250 ml container with nitric acid preservative, do not rinse out. **Note:** Care should be taken to insure a representative sample. It is very easy to contaminate a sample with trace metals. Tap water should run for one minute before taking samples. Avoid touching bottle tip with fingers. The samples need not be kept on ice but should be packed so as to avoid breakage or leakage.
Phenol:	Fill the container to the neck. Do not rinse out the preservative which has been added. The samples should be kept on ice before shipping. Ship the samples within 8 hours after sampling in the insulated container provided. The samples should arrive at the lab within 30 hours after sampling (an air delivery service should be used for out-of-town samples).
Base/Neutral and Acid Extractables-GC	1. Bottles contain sodium thiosulfate to reduce residual chlorine — do not rinse out. Slowly fill the one (1) liter bottle. 2. Place the septum (hard teflon side down) on the top of the bottle.

TABLE 3-14 (Continued)

Pollutant	Procedure
Base/Neutral and Acid Extractables-GC (Cont'd.)	3. Seal the sample with the screw cap. 4. Using waterproof ink, identify the sample with the information indicated on the labels. 5. Add a blue ice container to the shipment package and ship the sample to the lab within 48 hours.
Semi-Volatiles by Closed Loop Stripping	1. Bottles contain sodium thiosulfate to reduce residual chlorine — do not rinse out. Slowly fill the one (1) liter bottle to overflowing. 2. Carefully set the container on a level surface. Place the septum (hard teflon side down) on top of the bottle. 3. Seal the sample with the screw cap. **Note:** To insure that the sample has been properly sealed, invert the sample and lightly tap the lid on a solid surface. The absence of the entrapped air bubbles indicates a proper seal. If air bubbles are present, open the bottle, add additional sample, reseal and check again for bubbles. The sample must remain hermetically sealed until it is analyzed. 4. Using waterproof ink, identify the sample with the information indicated on the labels. 5. Add a blue ice container to the shipment package. **NOTE:** The samples must be kept at 4^{o}C during and prior to shipping. Samples should be shipped by a 48-hour (or less) delivery service.

2. When shipping, sample containers must be packed with ice to maintain temperatures and placed in an insulated chest.

3. It is imperative that samples be shipped in insulated ice chests as soon as possible.

4. It is imperative that all samples be handled in accordance with the chain of custody procedures.

Industrial Sampling and Laboratory Coordination

The ISB sampling program is seriously constrained by the limitations of the laboratory. The compounds which are currently analyzed by the laboratory (conventionals and heavy metals) are the only ones that the laboratory has the capability to analyze. The ISB sampling program is further constrained by the fact that the lab has the capacity to analyze only a limited number of samples of any one compound in a given week. The laboratory may communicate to ISB, for example, that it can only analyze x number of CN samples in a particular week and x number of Cu, CD, etc. ISB is forced to take laboratory limitations into consideration when preparing the weekly sampling schedule. Although ISB may sample for the full range of monitored pollutants at a particular industry, the total number of industries which can be sampled in a given week is limited by the fact that only a fixed number of compounds of each type can be analyzed by the lab.

Industrial Sampling Training Program

A full training program will need to be set-up which instructs sampling crews in the proper procedure for taking and preserving samples of various types. Separate course units will also be required to train crews in safety procedures, equipment, sample compositing, sampling custody requirements, and the transportation of samples. An example Industrial Sampling Training Program course description is provided in Appendix A.

POTW Monitoring Basis

POTW sampling every two weeks will provide a data base on the level of industrial pollutants entering the treatment plant and their removal by the treatment system. Monitoring industrial industrial pollutants is important because of the potentially harmful impact of these wastes on the treatment system performance, the possible pass through of the pollutants through the treatment system and into the environment, or the accumulation of pollutants in the sludges produced at the treatment plant which could effect sludge disposal. Additionally, sewer safety and integrity may be jeopordized by the discharge of some compounds. The monitoring of the wastewater would help prevent such problems from occuring by detecting changes in the wastewater characteristics or increases in the level of regulated pollutants.

Data obtained from POTW sampling provides useful information to ISB on changes in industrial discharges. Changes in the concentration of regulated compounds in the POTW influent can direct ISB monitoring emphasis to industry or industries which may not be in compliance with discharge limitations.

POTW monitoring will also verify the basis on which the industrial discharge limitations were established. Increased industrial discharge, either through increased discharge from existing industries, new industries, or from a change in unrelated industrial or residential activity, which could effect dilution factors or background concentration of regulated compounds and therefore, effect the basis and validity of the discharge limitation. As the recommended discharge limitations are based on current conditions, continued POTW monitoring will develop a historical record which can verify the basis for the limitation or indicate the need to reassess the limitation.

Interceptor sampling also provides useful information to ISB when unusual conditions are observed at the treatment plant or from POTW sampling. Because of the large area and the number of industries served by the treatment plants, it is difficult to determine the source of a large discharge of a regulated compound. By analyzing samples collected in the interceptors, ISB is aided in their efforts to determine the source of the discharge. While such sampling cannot positively identify the source of the discharge, it can direct ISB investigation to specific areas.

As discussed previously, POTW sampling should be performed every two weeks. This sampling frequency will provide an overall view of the wastewater characteristics throughout the year and generate statistically significant data. This level of sampling would not present a high analytical workload to the laboratory, as can be seen on Table 5-4 later in this report. There is frequently a need to perform additional analyses on POTW influent samples as a result of a slug discharge, unusual conditions, or in identifying the cause of a POTW upset when a toxic discharge is suspected. Unscheduled POTW samples and interceptor samples would be analyzed on an as-needed basis.

CHAPTER 4

CHAPTER 4

SAMPLING EQUIPMENT

GENERAL

As water quality regulations have developed over the past decade, there has been a steadily increasing concern over industrial discharges to City sewers. In response to that concern, the City of Indianapolis has gradually developed the existing Industrial Surveillance Branch Sampling Programs, and has acquired a substantial amount of sampling equipment such as vehicles, automatic composite samplers, and sewer safety equipment. The objective of this chapter is to review the existing ISB sampling equipment and determine what additional sampling equipment will be required to implement the monitoring program recommended in this report. The chapter will review both the equipment required for sampling the influent to the Belmont and Southport AWT's, as well as equipment need for sampling in sewer interceptors and at the discharge from individual industries.

During the development of the scope of work for this project, it was noted that the sampling equipment in use for monitoring the influent to the Belmont treatment plant was inadequate, while appropriate equipment for monitoring industrial dischargers was found to be available to the ISB. Consequently, the primary focus of this chapter is on the development of recommendations for equipment for sampling treatment plant influent and interceptor sewer flows.

EXISTING SAMPLING EQUIPMENT

Industrial Sampling Equipment and Staff

The existing industrial sampling equipment used by the ISB is listed on Table 4-1. None of the samples collected by ISB are flow proportioned because facilities for flow monitoring have not been provided at the industrial sites for ISB use and ISB does not have portable flow measuring equipment.

The ISB currently operates two field sampling crews of two men each. Each crew operates with one van and visits approximately six industrial site per day. This means that each crew can collect an average of six grab samples or three composite samples per day. Each composite requires two visits to the site, one to set the sampler and one to pick it up, while a grab requires only one visit. Each sampling visit requires approximately 30 minutes travel time and 30 minutes at the site. The remaining two hours per day is required for paperwork, equipment loading and unloading at the plant, and delivery of samples to the lab.

POTW and Interceptor Sampling Equipment

Belmont. The Belmont influent and effluent are currently sampled manually. The advanced wastewater treatment (AWT) facility at Belmont has eight

TABLE 4-1

INDUSTRIAL SURVEILLANCE SAMPLING EQUIPMENT

Samplers	Number
ISCO Model 1580	14
ISCO Model 2100	2
ISCO Power Pack	8
ISCO Rechargeable Battery	14
ISCO Multi-Battery Charger	1
pH Measurement	
pH Monitors (pH probe, meter, and strip chart recorder)	6
pH Meters, Graphic Controls (portable units with temperature compensation)	4
Safety Equipment	
Hard Hats	Lot
MSA-Explosivemeter (Type 2)	1
MSA-Explosivementer (Type 40)	1
Gas Analyzers (H_2S, O_2, explosive gas)	3 on order
Miscellaneous	
Marsh McBirney Model 201 Water Current Meter	1
Vehicles	
Vans (with 2-way radio and approximately 4 years old)	2 existing, 2 on order
Sedans (with 2-way radio and approximately 4 years old)	2

permanent sampling points in the process train for process control and monitoring. Eight sample pumps located at the sample points deliver samples to four sampling stations, which consist of a refrigerated automatic sampler and, in some cases, automatic TOC or NH_3-N monitors. Information on these sampling stations is provided in Table 4-2. No automatic sampling equipment has been installed on the Belmont influent or effluent. Future modifications at Belmont headworks will provide for automatic sampling of the influent.

Southport. Automatic sampling equipment has been installed at the Southport headworks for influent sampling. There are four additional automatic sampling stations in the Southport AWT for process control and monitoring. There is no sampling equipment installed for effluent sampling. The automatic sampling equipment installed at Southport is listed in Table 4-2

The Southport influent sampler was installed in the Screen Building to sample the raw sewage. The sampler takes a flow proportional sample. The sample is stored in a one-gallon container. The sampler is refrigerated at a temperature between 0 and 4 °C.

Interceptors

There are seven interceptors taking flow to the Belmont and Southport treatment facilities. Four serve the Belmont treatment plant which include Belmont, West Indianapolis, Harding and Adler-McCarty. Southport is served by the Southwest Diversion, West Marion County Interceptor, and South Marion County Regional Interceptor. There are a number of other interceptors which feed into these interceptors.

There are no automatic sampling stations on the interceptors. The interceptors have been sampled on occasion with portable samplers. The samples collected have not been flow proportioned as flow monitoring equipment is not available. Samplers used for this purpose have been 1SCO-1580 automatic samplers.

During the summer of 1982, the industrial Surveillance Branch began monitoring the four interceptors feeding Belmont. This was undertaken to determine the source of a high organic load coming into the plant. The samples were not flow proportional and made determination of the total load from each interceptor difficult. Initially, the samples were collected and analyzed daily to determine typical values of conventional parameters. Later on, the samples were analyzed only if unusual conditions were found on the Belmont influent. The sample locations used were as follows:

- Belmont Interceptor, Belmont Street entrance
- West Indianapolis, Harding Street entrance
- Harding, Harding Street entrance
- Adler-McCarty, east of Harding Street

TABLE 4-2

INDIANAPOLIS PRETREATMENT AWT SAMPLING EQUIPMENT AT BELMONT AND SOUTHPORT

Sampling Station	Sample Points Served	Equipment
Belmont-A	• Westbank Bio-Filter Effluent • Eastbank Bio-Filter Effluent • Clarifier Westbank Return Sludge • Clarifier Eastbank Return Sludge	• 4 Gorman-Rupp self-priming centrifugal 20 gpm, hp sample pumps. • 1 Refrigerated Liquid Composite Sampler Quadruple, Sample Unit, Sigmamotor, Inc. Model 6400/Flo-Thru Sampler with 1-gallon bottles. • 2 Ammonia Monitors, Orion Research, Inc., Model 1110 Ammonia, Series 1000. • 1 TOC Monitor, Astro Resources Corp., Model 1800 LTO Series TC/TOC.
Belmont-B	• Mixed-liquor: Westbank Aeration Tank Effluent	• 1 Gorman-Rupp self-priming centrifugal 20 gpm, 1 hp sample pump. • 1 Refrigerated Liquid Composite Sampler, Single Sample Unit, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler with 1-gallon bottle.

TABLE 4-2 (Continued)

Sampling Station	Sample Points Served	Equipment
Belmont-C	• Mixed liquor: Eastbank Aeration Tank Effluent	• 1 Gorman-Rupp self-priming centifugal 20 gpm, 1 hp sample pump. • 1 Refrigerated Liquid Composite Sampler, Single Sample Unit, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler with 1-gallon bottle.
Belmont-D	• Clarifier Effluent: Eastbank • Clarifier Effluent: Westbank	• 2 Gorman-Rupp self-priming centrifugal 20 gpm, 1 hp sample pumps. • 1 Refrigerated Composite Sampler, Triple Sample Unit, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler with 1-gallon bottles. • 2 Ammonia Monitors, Orion Research, Inc., Model 1110 Ammonia, Series 1000. • 2 Total Carbon Monitors (TOC), Astro Resources Corp., Model 1800 LTO, Series TC/TOC.

TABLE 4-2 (Continued)

Sampling Station	Sample Points Served	Equipment
Southport Influent	• Raw Sewage Forcemain	• Refrigerated Composite Sampler, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler with 1-gallon sample bottle. • pH Monitor, Great Lakes, Model 60 probe sensor with Model 70 transmitter. • Ammonia Monitor, Orion industrial Series 1000, Model 1110 with Ramoy Series 200 progressing cavity sample pump. • Temperature Sensor, 0-100°F. • TOC Monitor, Astro Resources Corp., Model 1800 LTO, Series TC/TOC.
Southport-A	• Westbank Bio-Filter Effluent • Eastbank Bio-Filter Effluent • Clarifier Westbank Return Sludge • Clarifier Eastbank Return Sludge	• 4 Gorman-Rupp self-priming centrifugal 20 gpm, 1 hp sample pumps. • 1 TOC Monitor, Astro Resources Corp., Model 1800 LTO, Series TC/TOC. • 2 Ammonia Monitors, Orion Research, Model 1110 Ammonia, Series 1000.

TABLE 4-2 (Continued)

Sampling Station	Sample Points Served	Equipment
Southport-A (Cont'd.)		• Temperature Sensor, Moore Ind., Model ICT-J-2-2-5 MVS In-line Sensor in Transmitter. • 1 Refrigerated Composite Sampler, Sigmamotor, Inc., Model 6400 Flo-Thru Sampler quadruple sample unit with 1-gallon bottles
Southport-B	• Mixed liquor: Westbank Aeration Tank Effluent	• 1 Gorman-Rupp 20 gpm 2 hp sample pump. • 1 Refrigerated Composite Sampler, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler, Single Sample Unit with 1-gallon bottle. • Temperature Sensor.
Southport-C	• Mixed liquor: Eastbank Aeration Tank Effluent	• 1 Gorman-Rupp 20 gpm 1 hp sample pump. • 1 Refrigerated Composite Sampler, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler, Single Sample Unit with 1-gallon bottles. • Temperature Sensor.

TABLE 4-2 (Continued)

Sampling Station	Sample Points Served	Equipment
Southport-D	• Clarifier Effluent-Eastbank • Clarifier Effluent-Westbank • Air Nitrification System Effluent	• 3 Gorman-Rupp centrifugal sefl-priming 20 gpm, 2 hp sample pumps. • 1 Refrigerated Composite Sampler, Sigmamotor, Inc., Model 6400/Flo-Thru Sampler, Triple Sample Unit with 1-gallon bottles. • 1 TOC Monitor Astro Resources, Model 1800 LTO, Series TC/TOC. • 1 Ammonia Monitors, Orion Research, Inc., Model 1110 Ammonia, Series 1000. • Tefmperature Sensor

ADDITIONAL SAMPLING EQUIPMENT REQUIREMENTS (Task 11.2)

Southport Influent Sampler

The Southport influent sampler was installed for collecting samples for conventional analysis and was not designed for industrial pollutant sampling. Some problems may be encountered when the samples are used for priority pollutant analysis. The solenoid valve, as installed, may not receive adequate flow to continually flush the valve body when in the off position. This could allow sewage to remain in contact with the valve body between samples. As the valve body in contact with liquid is brass, some contamination of the sample by metals could occur. Other valve materials are of teflon and stainless steel and of less concern. The degree of contamination will depend on the amount of flushing achieved, interval between sampling, and the size of the sample taken. Repositioning the valve to assure adequate flushing and replacement of the valve with an inert material is recommended. The sample tube is partly a Tygon-type tube. Plasticizers used in this type of tubing could also lead to contamination. This can be minimized by assuring that the tube does not contact the sample in the storage container, and that the tube drains completely. Replacement of the tube with a Teflon tube would be a more acceptable solution.

The sample container supplied is plastic; while this would be suitable for metals sampling, it would present problems for priority organic samples. Substitution of a glass container is recommended. A larger container size is also desirable; at least two gallons of sample should be collected due to the number of analyses to be performed and the minimum quantity of sample required for each analysis.

Volatile organic sampling is a problem with this type of sampler, as the loss of volatile components cannot be prevented. When volatile organic samples are required, it is recommended that they be collected manually as discrete samples. The samples should then be composited under controlled conditions by qualified personnel to assure minimal volatilization or contamination.

A single sample container does not permit the use of sample preservatives specific for each analysis. As the sampler is refrigerated this problem minimized, providing that the sample is removed promptly and transferred to containers with the proper preservative. Alternatively, the sampler could be replaced or modified to take multiple samples which would permit the use of preservatives for each sample type. If this were done, a minimum of five samples would need to be collected, each containing a different preservative as listed in Table 4-3, if analyses for all priority pollutants are to be run. Unless significant deterioration in wastewater characteristics is noted, it is not recommended that the sampler be modified to take multiple samples.

TABLE 4-3

SAMPLE PRESERVATIVES

Sample Type	Preservative
Extractable and Purgeable Organics	Cool to 4°C, $Na_2S_2O_3$
Cyanide	Cool to 4°C, NaOH to pH 12
BOD	Cool to 4°C
COD	Cool to 4°C, H_2SO_4 to pH 2
Phenolics	Cool to 4°C, H_2SO_4 to pH 2
Metals	Cool to 4°C, HNO_3 to pH 2

Belmont Influent Sampler

There are several alternatives for sampling the Belmont influents as listed below:

- Manual Sampling
- Automatic Sample Collection, Single Sample
- Automatic Sample Collection, Multiple Samples

The manual sampling alternatives would require that the Belmont personnel collect additional samples for industrial monitoring along with the usual plant samples. The automatic sampling alternatives would require the installation of sampling facilities at the Belmont headworks. The difference between single sample and multiple sample collection is that with multiple sample collection it is possible to add preservatives to samples; this is not possible with single sample collection, as preservative requirements depend on the analyses performed.

It is recommended that automatic sample collection equipment be installed at the Belmont headworks. Single sample collection should be adequate for the needs of industrial monitoring, as no sigificant change in wastewater characteristics should occur during the collection period due to a lack of preservatives.

Attention should be given to priority pollutant sampling requirements in the selection of the sampling equipment. Specific considerations are:

- Flow proportioned samples.
- Only teflon, stainless steel or glass materials should be in contact with the sample.
- Lines, valves, and fittings should have no dead space and should drain completely.
- Sampler should be refrigerated at 4^{o}C.

Until a permanent influent sampling station can be constructed at Belmont, sampling can be done either manually or with a portable flow proportioning sampler.

As accurate volatile organic sampling cannot be performed automatically without a highly specialized sampler, it is recommended that any samples for volatile organic analysis be collected manually.

Interceptor Samplers

Each of the interceptors entering the Belmont treatment plant were inspected for its suitability as a sampling location. In addition to these interceptors, some of the upstream interceptors were also inspected for sampling locations. Sampling in the upstream interceptors would permit further isolation of important industrial areas in Indianapolis and would facilitate the Industrial Surveillance Branch monitoring abilities.

Suitable sampling locations were determined by accessibility of the location, the ability to monitor flow, and the isolation of various industrial areas. Most of the interceptors were readily accessible and generally do not present access problem. Flow monitoring presents some problem, as none of the interceptors were provided with flow monitoring equipment or stations, and it would be difficult to install flow monitoring equipment such as flumes or weirs. An alternate method of flow measurment must therefore by used. The use of open channel flow hydraulic equations and liquid level measurements can provide suitable accuracy, provided certain conditions are met. The important conditions are hydraulic grade or sewer invert should be uniform for several hundred yards upstream of the measuring station; that there be no enlargements or contractions in the line in this length; and there are no entrances or exits in this length. Suitable flow coefficients must also be used and are determined by the condition of the sewer. An accuracy of five to ten percent can be achieved by this method.

Isolation of the significant industrial areas is a problem because of cross connections between interceptors. The interceptors may have several cross connections, and the direction of flow and quantity of flow vary with hydraulic conditions. No efforts have been made to determine the magnitude of the problem, and the cross connections would have on interceptor flow and sampling.

The recommended sample locations are given on Table 4-4 and Figure 4-1. The current equipment for industrial and interceptor sampling (ISCO 1580 samplers) is adequate for none flow proportioned samples. Should a flow proportioned sample be required, it would be necessary to install a level measuring device and use flow proportioning, or a sequential sampler, and proportion the sample from the flow record. Level measuring equipment, which automatically converts the measurement to flow, can be obtained from various vendors (Manning, ISCO, etc.).

The recommendation for interceptor sampling is to acquire flow measuring equipment and flow proportioning samplers for the four major interceptors at the Belmont POTW. No interceptor sampling is envisioned at the present for Southport. Two of the recommended interceptor sampling stations, West Indianapolis and Harding, could have permanent monitoring stations built with power. The remaining interceptors should continue to use portable equipment due to their isolation.

Industrial Sampling Equipment

City Monitoring. The current equipment used for industrial monitoring is adequate for non-flow proportioned samples. As most industrial sampling will not be flow proportioned, there is no urgency for ISB to acquire more sophisticated samplers for industrial monitoring. ISB currently has two ISCO 2100 samplers which can take flow proportioned samples. It is recommended that ISB acquire flow measuring equipment for use with these samplers.

TABLE 4-4

RECOMMENDED INTERCEPTOR SAMPLING LOCATIONS

	Location
Major Interceptors	
Belmont	Belmont Street north of Security Gate
West Indianapolis	Harding Street Security Gate
Harding Street	Harding Street Security Gate
Adler-McCarty	Eastside of Harding Street
Minor Interceptors	
Pleasant Run	Southern Avenue Diversion
Adler-McCarty	Central Gulf Railroad Yard
Pleasant Run	Prospect Avenue

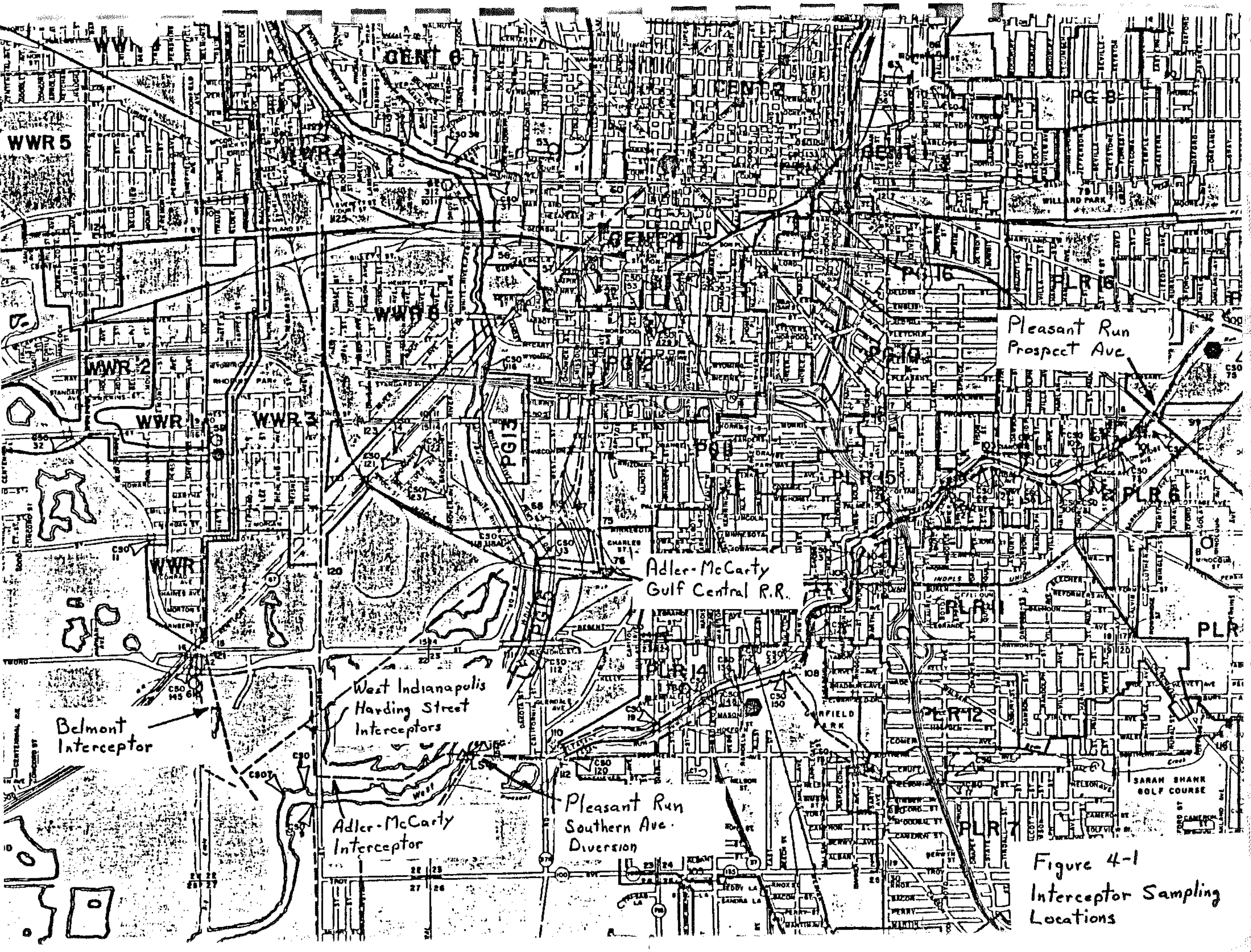


Figure 4-1
Interceptor Sampling Locations

Portable water level sensing equipment and removable weirs or flumes should be obtained for flow monitoring equipment. Water level sensing equipment can be obtained from various vendors (Manning, ISCO, etc.). A variety of portable weirs or flumes should be obtained to meet the varying conditions encountered at industrial sites. Portable weirs and flumes can be obtained from a variety of vendors (Thel-Mar Co., N.B. Instruments, etc.). IBS equipment recommendations are given in Table 4-5, and an estimate of the cost of this equipment is given in Table 4-6.

Several other cities have reported good results from the issue of uniforms for industrial wastewater sampling personnel. In particular, Chicago outfits their sampling personnel to the point where they resemble police. This has several positive impacts, such as increased respect for the samplers on the part of industry and a corresponding increase in morale and pride in good work on the part of the sampling personnel. It is suggested that the City of Indianapolis consider issuing a simple uniform (such as beige shirts and slacks) to its sampling personnel. Because these personnel are in frequent contact with the public and industry, helping them to project the appearance of precision and importance will both aid them in their work and improve City public relations. The purchase and issue of uniforms should however be thoroughly discussed with the employees who would wear them befor such a program would be implemented.

In general, the ISB is adequately equipped to conduct an industrial surveillance program. As in the case of any ongoing program, equipment must be replaced and upgraded when it becomes necessary. As indicated in Table 4-1 earlier in this chapter, the ISB currently has some replacement equipment (vehicles) on order, along with some equipment that improves their gas monitoring capabilities in sewers. Such planned purchases demonstrate the existence of effective means for providing and maintaining sampling equipment for the ISB. The equipment recommendations listed on Table 4-5 represent improvements to a currently adequate equipment supply.

Self-Monitoring. In general, the choice of equipment to be used by industries which self-monitor is left to those industries subject to the constraints of proper sampling practice. It is possible to collect composite samples manually, but industries will find it more economical to purchase automatic samplers. Such samplers should be refrigerated, particularly if the industry discharges BOD above the surcharge limit. Just as in the case of the ISB, flow proportioning is not strictly necessary for self-monitoring. However, the side diurnal discharge flow variations for industries which operate only during part of each day may result in large error in measured pollutant loads if samples are not flow composited. When an industry is paying a sizeable permit or surcharge fee on the basis of the samples, it is often economically wise to employ flow compositing. The City should encourage such industries to install facilities for flow monitoring facilities and take flow proportioned samples.

No specific recommendation can be given as to the type of flow measuring or sampling equipment due to the varying conditions encountered; the following general guidelines are provided:

TABLE 4-5

INDUSTRIAL SURVEILLANCE EQUIPMENT RECOMMENDATIONS

Flow Monitoring

Manning, ISCO, Stevens, or similar water level sensing equipment suitable for use with ISCO Model 2100 samplers (2 sets needed)

Portable weirs and flumes, 6, 8, 10 and 12-inch size (2 sets needed)

Safety Equipment

Safety harness
Tripod
Self-contained breathing equipment

Uniforms

Shirt and slacks
Coveralls
Safety shoes

TABLE 4-6

RECOMMENDED EQUIPMENT COST ESTIMATE

Equipment		
2 water level meters		$ 800
2 sets of flow metering weirs		$ 500
1 safety harness with tripod		$ 250
1 self-contained breathing apparatus		$1,200
Uniforms		
Safety shoes	12 pr	$ 350
Shirt	50	$1,000
Slacks	25	$ 600
Coveralls	25	$1,000
	Total Cost of Recommended Equipment	$5,700

- Sampling equipment in contact with the sample should be teflon, stainless steel, or glass. An exception can be made to allow the use of plastic sampling equipment when no priority pollutant organics are to be measured.
- Samplers should be refrigerated at 4°C.
- Samples should be taken from manholes easily accessible to both the City and the industry, preferably with flumes or removable weirs installed.

Sampling Procedures

Standard operating procedures were discussed previously in Chapter 3. Additional sampling information is presented in Appendix A. Special sampling procedures pertaining to POTW, interceptor, and industrial samples is given below.

POTW Samples. General sampling procedures were presented in Chapter 3. Special POTW sample collection procedures are presented below:

1. Remove sample container from sampler promptly at end of sampling period.
2. Install clean sample container.
3. Inspect sampler and correct problems found. Not that samples are being kept cold (4°C), proper volumes are being collected. Check sample lines and tubing and replace or clean as necessary.
4. Check collected sample. Note any unusual conditions.
5. Check that sample is properly identified.
6. Store sample in laboratory cold storage room.
7. For samples to be analyzed, transfer the sample into bottles containing preservatives promptly.
8. Collect samples daily.
9. Hold all collected POTW samples for 48 hours for upset analysis. If not plant upset occurs, pour sample out.

Interceptor Samples

1. Remove sample from sampler promptly at end of sampling period.
2. Install clean sample container.

3. Inspect sampler and correct problems found. Note that samples are being kept cold and proper volumes are collected. Check sample lines and tubing and replace or clean as necessary.

4. Check operation of flow monitoring equipment.

5. Check collected sample. Note any unusual conditions.

6. Check that sample is properly identified.

7. Store collected samples in laboratory cold storage room.

8. Collect samples daily.

9. Hold interceptor samples a minimum of 48 hours. If POTW upset analysis is performed, hold interceptor samples and analyze accordingly. Pour out samples not analyzes.

10. For samples to be analyzed, transfer sample to containers with preservatives.

Industrial Samples

1. Collect sample from self-monitoring industries within 24 hours. For City-monitored industries, collect samples and remove samplers promptly at end of sampling period.

2. Check that sample is properly identified.

3. Submit all collected industrial samples to the laboratory for analysis.

4. Sample not analyzed immediately should be transferred to bottles containing preservatives and stored at 4^{o}C.

CHAPTER 5

CHAPTER 5

LABORATORY FACILITIES FOR INDUSTRIAL MONITORING

GENERAL

As concern over industrial discharges to municipal wastewater systems has increased over the past decade, the laboratories which serve the municipal treatment works have been called upon to perform more and more specialized analyses for industrial pollutants in addition to the conventional analyses required for process control in plants treating primarily domestic sanitary wastes. Laboratories like the Belmont Laboratory (which serves both the Indianapolis treatment plants) have found themselves purchasing sophisticated instrumentation, hiring more highly trained technicians, and crowding more activity into their available lab space in response to the demands of expanding pretreatment program and treatment plant process control sampling activities. The Belmont Laboratory has been recently moved to newly constructed quarters and outfilled with additional equipment in conjunction with the construction with the two new AWT plants in Indianapolis. The purpose of this chapter is to inventory the Belmont Laboratory facilities, evaluate both their capacity and the level of their current utilization, and on this basis develop recommendataions that will enable the lab to meet the needs of the Pretreatment Program Industrial Surveillance Monitoring Program.

During the scoping of this pretreatment project, it was recognized that some laboratory facilities required for priority pollutant analyses, such as atomic absorbtion, gas chromatagraph (GC), and mas spectrophotometer (MS) facilities are only available in relatively large increments of capacity. In other words, the high-capital cost of equipment to run two GC/MS analyses per year is the same as that to run hundreds of analyses per year. If the Belmont Lab must operate such facilities to analyze a limited number of Indianapolis samples, it may be possible to improve the utilization of capacity for such facilities (and thus lower the cost per analysis) by offering to provide regional analytical services for a number of public treatment works in Indiana. Therefore, one of the objectives of this chapter is to evaluate the feasibility of operating the Belmont Laboratory as a regional laboratory.

To accomplish the objectives stated above, this chapter will first describe the existing Belmont Laboratory facilities, and then, on the basis of an evaluation of the utilization of present capacity, make recommendations for improvements required to support implementation of the pretreatment program monitoring program described earlier in this report. Finally, the chapter will discuss the concept of a Belmont Regional Laboratory and determine whether it could benefit the City of Indianapolis.

REVIEW OF EXISTING LABORATORY FACILITIES

The Indianapolis wastewater laboratory is located at the Belmont Treatment Plant. The laboratory receives samples from the Belmont and Southport treatment plants for process control and monitoring requirements. Industrial surveillance samples are also received and analyzed by the laboratory.

The laboratory has approximately 8,000 square feet of space. It currently has a staff of 14, with a potential staff of 35. The laboratory is well equipped from a physical (equipment and space) standpoint, and has a good layout for conventional analyses. Table 5-1 lists the major analytical equipment in the lab. Separate space has been provided for the following analyses:

CN
Ammonia, Total Keldhal Nitrogen
Oil & Grease
BOD
Heavy Metals (2 rooms, one for each instrument)
NO_2, NO_3, & PO_4
Gas Chromatagraph
Clean-up
Storage
Balance

EVALUATION OF LABORATORY CAPABILITY

Laboratory capabilities, with respect to industrial surveillance activities, can be broken down into the following categories:

- Conventional pollutants (BOD, COD, pH, Solids)
- Industrial Pollutants
  - Heavy Metals
  - Oil & Grease, Cyanide, Phenols
  - Volatile and extracted organics (G.C. testing)

The capability of the Belmont Laboratory to perform the analyses in these groups depends on the availability of the proper equipment and trained staff. The capacity of the lab to process large numbers of each type of analysis depends on sample and data management facilities, as well as staff and equipment. As can be seen on Table 5-1, the laboratory has the equipment required to run any of the analyses required for industrial monitoring. At the end of 1982, there was at least one trained staff member capable of operating each piece of equipment. Therefore, the lab has the capability to run all ISB analyses.

The definition of the lab capacity in terms of the number of each type of analysis that can be run requires a more detailed evaluation. Table 5-2 presents the results of such an evaluation. The table first lists the number of analysis that can be run by the lab with the existing 17 person staff and equipment. These

TABLE 5-1

INDIANAPOLIS PRETREATMENT
INVENTORY OF MAJOR BELMONT
LABORATORY ANALYTICAL EQUIPMENT

	Equipment Item	Analytical Purpose
1.	H.P. 5840 Gas Chromatagraph with ECD, FID, and T.C. detection systems, and an H.P. 5840A G.C. data terminal.	Analysis of specific organics priority pollutants, pesticides, PCB's, phenolics, solvents.
2.	Spectrametrics Incorp. S.M.I. III Direct current plasma (DCP) analyzer with T.I. 700 Data Terminal.	Analysis of priority pollutant metals.
3.	Instrumentation Laboratories I.L.-751 Atomic Absorbtion analyzer, dual channel, with graphite furnace, Honeywell chart recorder, and auto-hydride system.	Analysis of priority pollutant metals.
4.	Technicon Auto-Analyzer, single channel, with digital digester, and modules for PO_4, NO_3, and NO_2	Colorimetric analysis of COD, NH_3-N, NO_3, NO_2, PO_4, and other parameters.
5.	Dohrman DC-54 Total Organic Carbon Analyser	TOC Analysis
6.	Ionics Total Oxygen Demand Analyzer	TOD Analysis
7.	Fisher Automatic Titrator with Model 390 Burette, Model 386 printer, and Fisher Recordall Series 5000	Wet Chemical analysis of various pollutants and water quality parameters.
8.	Walk-in BOD incubator, approximately 100 sq ft	BOD Analyses
9.	Walk-in Sample cold room, approximately 150 sq ft	Sample Storage
10.	22 Fume Hoods	COD, TKN, AA, CN, and other analyses and instruments.
11.	5 Drying ovens and 5 muffle furnaces	Solids Analyses
12.	Distilled Water Supply	BOD dilution water
13.	Two-12 sample TKN digestion Units	TKN Analysis
14.	One-44 sample COD Block Digester	COD Analyses
15.	Heaters, condensers, burettes, stirrers, spectrophotometers, separatory funnels, specific ion electrodes, and other miscellaneous equipment	Wet chemical test procedures for G.C. extractions, Oil and Grease, Cyanide, Phenol, NH_3-N and other analyses.

TABLE 5-2(a)

INDIANAPOLIS PRETREATMENT PROGRAM
BELMONT LABORATORY ANALYTICAL CAPACITY

Analysis	Laboratory Capacity, Analyses per Year Current Staffing (1)	Maximum Staffing (2)
BOD	10,000	30,000
Solids (Total, Suspended, Volatile, etc.)	20,000	60,000
COD	2,600	10,000
TOC	0 (3)	10,000
NH_3	3,000	6,000
TKN	2,600	5,200
NO_2, NO_3	3,400	3,400
PO_4	3,400	3,400
O&G	4,000	8,000
pH	20,000	50,000
Turbidity	2,600	2,600
Coliforms	2,600	5,200
Hardness	2,300	2,300
Chlorides	1,700	1,700
Alkalinity	3,400	3,400
Metals	6,000 (4)	21,000 (5)
Phenols	400	4,000
Cyanide	2,000	4,000
G.C. Test	250-1,000	250-1,000

(1) 1983 staff of aproximately 17.
(2) Ultimate design staffing of 35, limited by overall lab space.
(3) TOC machine is not currently staffed.
(4) D.C. Plasma Analyzer is not currently staffed.
(5) Assumes auto-samplers acquired for both AA and D.C.P.

TABLE 5-2b

INDIANAPOLIS PRETREATMENT
BELMONT LABORATORY

No.	Analytical Area	1982 Staff (man/year)	Estimated Staff Required for ISB 1984 Sampling (man/year)(1)	Estimated Ultimate Staffing Lab Capacity (man/year)
201	BOD	2-1/2	2-1/2	6
202	COD	3/4	3/4	2
203	TOC	2/3	1/2	1
204	Solids	2	2	5
206	pH	1/2	1/2	1
207	Oil and Grease	1/3	1	1
208	T.K. Nitrogen	3/4	3/4	2
209	Ammonia	3/4	1 + 1/4	2
210	Phosphorus	1/2	1/2	1/2
121	Cyanide	1/2	1	1
213	Phenols	1/2	1	1
214	Heavy Metals	1	2 + 1/2	2 + 1/2
216	Organics by G.C.	1	1	1
231	Nitrate and Nitrite Nit.	1/2	1/2	1/2
233	Alkalinity	1/3	1/3	1/2
235	Hardness	1/3	1/3	1/2
—	Chloride	1/3	1/3	1/2
245	Coliforms; Fecal	1/2	1/2	1/2
—	Turbidity	1/4	1/4	1/2
	Subtotal	14	18	29
	Quality Assurance	0	1	1
	Dishwashing	0	0	1
	Admin. and Supervision	3	3	4
	Total	17	22	35

(1) Estimated staff for 1984 assumes implementation of Monitoring Option II-A, per Tables 3-7(b), 3-9, and 3-11.

numbers are based on estimates of the amount of time each analysis takes both in terms of manhours and in terms of machine-hours. The second column in Table 5-2 lists the annual analytical volume possible with a full staff of 35. This is the largest staff that could work in the Belmont Lab without unreasonable crowding. It represents a maximum lab capacity based on space limitation alone. Under full staff conditions, the number of analyses is primarily limited by equipment rather than manpower. The full staff capacity estimate was made assuming that data management and sample storage and handling do not constrain capacity. As will be discussed below, operational (and possibly equipment) changes will be required to prevent data and sample management from limiting lab capacity.

Conventional Pollutants

The capacity of the laboratory for conventional pollutants analyses is quite large. These analyses are usually limited by such things as BOD incubator space and COD hood space. The Belmont Lab is generously provided with these. Thus, staffing is really the main constraint on analytical volume for conventional pollutants. The addition of an extra shift in potentially limited areas, such as solids could overcome limitations in these areas.

Industrial Pollutants

Heavy Metals. The Belmont Lab is equipped with two analytical machines which can be used to run heavy metals. One is an AA unit (atomic absorption) and the other is a DCP (Direct Current Plasma) analyzer. Due to the differences between metals, the AA is the equipment choice for some, while the DCP is used for others. Typically, samples are analyzed by first doing several preparation steps (digestion, filtration, pH adjustment, evaporative concentration) on the whole sample. These steps must be done soon after the sample reaches the lab. Once the sample is prepared, it is stable and can be safely stored without loss of accuracy. The analytical machines are generally scheduled to run only one or two metals per day to minimize time spent readjusting equipment to suit individual metals. Thus, the lab would generally work through metals samples on a weekly rather than daily schedule.

The Belmont Laboratory performed about 1,500 metals analyses in 1982. The number of analyses run was primarily a function of the amount of time that trained staff were able to devote to operating the AA unit. The 6,000 metals analysis per year volume listed for current staff on Table 5-2 is based on the assumption that one trained analyst would be devoted full-time to metals analyses. The 21,000 analysis volume listed for the maximum staffing case assumes two full-time and one part-time AA and ICP operators and is equal to the capacity of the existing equipment if operated eight hours per day, 5 days per week. As discussed in the sectijon below on recommendations, auto samplers will be needed to handle the maximum volume without excessive staffing.

Oil and Grease, Cyanide, and Phenols. Oil and Grease, Cyanide, and phenols are analyzed by wet chemical methods involving the use of glassware and relatively inexpensive instruments such as spectrophotometers. Thus, the limits on lab capacity for these analyses are imposed by space and staff rather than equipment. However, it is possible to automate time consuming manual analyses (such as cyanide) using the Technicon autoanalyzer, as discussed in the section below under recommendations. It is therefore possible that the laboratory capacity for cyanide (and perhaps also phenols) listed in Table 5-2 could be improved upon by addition of equipment. The Oil and Grease analytical volume can be increased to meet demand relatively easily by use of additional glassware, bench space, and a moderate increase in staff.

Organics. The laboratory is equipped with a G.C. machine complete with a wide range of accessories and detector systems. The unit is capable of running any of the G.C. procedures required to analyze for organic compounds of concern in Indianapolis. The machine requires a great deal of adjustment and standardization effort, not to mention a significant amount of research or study time on the part of its operator necessary to stay current with developments in the field of G.C. analysis. The laboratory is currently equipped and staffed in an appropriate manner for running a limited number of samples by G.C. This is in keeping with the planned use of G.C. for special problem oriented analyses rather than routine high volume work. The range of G.C. analyses that can be run per year, listed on Table 5-2, is a function of the number of compounds for which analyses are run. If more compounds are to be identified, set-up time increses and analysis volume decreases. If each sample must be analyzed for volatiles, base-neutral extractables, acid extractables, and pesticides and PCB's, only 250 samples can be run, compared to 1,000 per year if only one G.C. procedure is run on each sample.

Comparison of Laboratory Capacity and Workload

The evaluation of the capacity of the Belmont Lab is partly a function of the demand placed upon the lab. The capacity estimate on Table 5-2 is based on the assumption, for example, that a high demand will be placed upon the lab for BOD analyses and for metals, compared to a low volume demand for G.C. work. It is necessary to review the actual workload projected for the lab to determine whether staff are correctly allocated between analytical areas. A comparison of projected workload and estimated capacity also clearly indicates changes and improvements required in the lab.

Table 5-3 presents an estimate of the conventional pollutant analytical workload projected for the lab just for process control for the two new AWT plants. This estimate was made by the Belmont Lab staff. The totals for the conventional analyses listed on Table 5-3 are carried over to Table 5-4 which lists in addition the industrial pollutant analytical workload that will be required. The industrial pollutant analytical workload is broken down into the load for routine industrial monitoring, AWT influent and interceptor monitoring, and special problem oriented (enforcement) analyses.

As can be seen on Table 5-4, the AWT process control workload will stress the existing lab capacity for BOD and solids analyses. Additional staff will be

TABLE 5-3

INDIANAPOLIS PRETREATMENT PROJECT
PROJECTED 1983 BELMONT LABORATORY WORKLOAD
FOR AWT OPERATIONS ANALYSES (1)

Analysis	Analyses Required Per Year: Belmont AWT	Southport AWT	Solids Handling	Total
BOD_5: Total	4,015	3,650	-	7,665
BOD_5: Soluble	1,512	1,512	-	3,024
BOD_5: Settled	730	730	-	1,460
BOD_5: Inhibited	1,460	1,460	-	2,920
BOD_L: (Ultimate)	12	12	-	24
TOC: Total	365	365	-	730
TOC: Dissolved	52	52	-	104
COD: Total	4,745	4,380	1,460	10,585
COD: Dissolved	1,460	1,825	-	3,285
Total Suspended Solids	7,300	6,570	1,825	15,695
Volatile Suspended Solids	5,475	4,745	1,825	8,760
Total Solids	3,285	3,650	1,825	8,760
Volatile Solids	3,285	3,650	1,825	8,760
Settled Suspended Solids	730	730	-	1,460
NH_3-N	4,015	3,285	365	7,665
TKN	2,956	2,579	12	5,547
NO_2-N	1,460	1,460	-	2,920
NO_3-N	1,460	1,460	-	2,920
$NO_2 + NO_3$-N	104	104	-	208
Soluble Org. N	52	52	-	104
Total PO_4-P	1,460	1,460	-	2,920
Soluble PO_4-P	52	52	-	104
pH	5,110	4,745	3,285	13,140
Hardness	52	52	-	104
Chloride	365	365	-	730
Alkalinity	1,929	1,929	-	3,858
Oil and Grease	24	24	-	48
Turbidity	1,460	1,460	-	2,920
Fecal Coliform	469	469	-	938
Microscope Exam	730	730	-	1,460
Overall Total Count	56,124	53,557	12,422	122,103

1. Workload excluding I.S.B. analytical needs, as projected by Belmont Laboratory staff.

TABLE 5-4 (a)

INDIANAPOLIS PRETREATMENT
BELMONT LABORATORY PROJECTED WORKLOAD
(Analysis Selection Option I, Monitoring Option A)

Analysis	AWT (1) Process Control Workload (analyses/year)	AWT Influent and Interceptor Monitoring (analyses/year	ISB Routine (2) Industrial Monitoring Workload (analyses/year)	Enforcement and (3) Other Special ISB Samples (analyses/year)	Total Workload (analyses/year)
BOD	15,000	200	1,502	100	16,802
Solids	46,000	200	1,432	100	47,732
COD	14,000	0	0	0	14,000
TOC	800	0	0	0	800
NH_3	7,700	200	1,162	100	9,162
TKN	5,600	0	0	0	5,600
NO_2, NO_3	3,200	0	0	0	3,200
PO_4	3,100	0	0	0	3,100
O&G	0	200	1,226	100	1,526
pH	13,000	200	1,872	100	15,172
Turbidity	3,000	0	0	0	3,000
Coliforms	1,000	0	0	0	1,000
Hardness	100	0	0	0	100
Chlorides	800	0	0	0	800
Alkalinity	3,800	0	0	0	3,800
Metals	0	1,600	9,654	800	12,054
Phenols	0	200	1,162	100	1,462
Cyanide	0	200	1,266	100	1,566
G.C. Tests	0	100	100	50	250

(1) Projected for 1983, per Table 5-3.

(2) Projected per Table 3-10, excluding analyses on 100 enforcement samples.

(3) These enforcement samples are included on Table 3-10.

TABLE 5-4(b)

INDIANAPOLIS PRETREATMENT
BELMONT LABORATORY PROJECTED WORKLOAD
(Analysis Selection Option II, Monitoring Option A)

Analysis	AWT (1) Process Control Workload (analyses/year)	AWT Influent and Interceptor Monitoring (analyses/year	ISB Routine (2) Industrial Monitoring Workload (analyses/year)	Enforcement and (3) Other Special ISB Samples (analyses/year)	Total Workload (analyses/year)
BOD	15,000	200	1,128	100	16,428
Solids	46,000	200	1,110	100	47,410
COD	14,000	0	0	0	14,000
TOC	800	0	0	0	800
NH_3	7,700	200	1,122	100	9,122
TKN	5,600	0	0	0	5,600
NO_2, NO_3	3,200	0	0	0	3,200
PO_4	3,100	0	0	0	3,100
O&G	0	200	1,098	100	1,398
pH	13,000	200	1,296	100	14,596
Turbidity	3,000	0	0	0	3,000
Coliforms	1,000	0	0	0	1,000
Hardness	100	0	0	0	100
Chlorides	800	0	0	0	800
Alkalinity	3,800	0	0	0	3,800
Metals	0	1,600	9,034	800	11,434
Phenols	0	200	1,116	100	1,416
Cyanide	0	200	1,124	100	1,424
G.C. Tests	0	100	100	50	250

(1) Projected for 1983, per Table 5-3.

(2) Projected per Table 3-11, excluding analyses on 100 enforcement samples.

(3) These enforcement samples are included on Table 3-11.

required to handle the load for these analyses. The ISB addition to this conventional pollutant workload are relatively small compared to the total, so ISB plans should not significantly impact the lab staffing needs.

On the other hand, the industrial monitoring workload makes up the entire total for metals, cyanide, phenols, and Oil & Grease analyses, and the lab capacity will be stressed for these analyses also. Thus, it appears that the lab needs to hire staff to handle industrial pollutant analytical needs. Approximately 3 to 4 additional technicians will be needed to perform cyanide, phenols, and Oil and Grease, and to run metals analyses on the AA and DCP machines.

RECOMMENDED INDUSTRIAL POLLUTANT ANALYTICAL PROCEDURE

General

The City of Indianapolis must have the capability to measure all 129 priority pollutants in the AWT influent on at least a semi-annual basis to conform to EPA pretreatment program guidelines. The City must also be capable of analyzing such important industrial pollutants as gasoline and Oil and Grease to properly control the effect of such pollutants on the sewers and treatment plant. The analytical procedures recommended for pollutants of interest to the ISB are listed in Table 5-5 and discussed below. In addition, Appendix C presents a set of recommended laboratory Standard Operating Procedures.

Metals

The metals arsenic, cadmium, lead, and mercury should be analyzed by AA (atomic absorption) in some cases using the graphite furnace. The metals chromium, copper, nickel, and zinc should be analyzed using the DCP machine. This will result in a relatively well balanced workload between the two analyzers in the lab. Samples to be analyzed for silver, selemium, thallium, berillium, and antimony can be sent to an outside laboratory for analysis rather than worked into the AA or ICP schedules, because only about four samples will need to be analyzed each year (Southport and Belmont influent). The time spent setting and standardizing the equipment for these metals will be excessive compared to the normal time per analysis for other metals. These metals are not found in significant quantities in Indianapolis wastewater.

Organic Compounds

The gas chromatagraph at the Belmont Laboratory should be utilized to analyze for the organic compounds of concern listed on Table 5-6 using the EPA methods indicated in the table. In addition, the laboratory should have the capability to analyze for phenols by the 4AAP (EPA 420.1) method and for Total Organic Halogen (TOX) using the Gas Chromatagraph. As shown on Table 5-7, these are broad-spectrum analyses that can economically be used to detect the presence of a number of compounds.

TABLE 5-5

INDIANAPOLIS PRETREATMENT RECOMMENDED INDUSTRIAL POLLUTANT ANALYTICAL PROCEDURES

Pollutant	Recommended Procedure
Oil and Grease	Extraction, EPA 413.1
Arsenic	Graphite Furnace, EPA 206.2
Cadmium	Atomic Absorption, EPA 213.2
Chromium (T)	D.C.P.[1], ASTM proposed method, 1980, Part 31, pg 1373
Chromium (VI)	Colorimetric
Copper	D.I.C.P., ASTM proposed method, 1980, Part 31, pg 1373
Lead	Graphite Furnace, EPA 239.2
Mercury	Atomic Absorption, EPA 245.1
Nickel	D.C.P., ASTM proposed method, 1980, Part 31, pg 1373
Zinc	D.C.P., ASTM proposed method, 1980, Part 31, pg 1373
Phenol	4AAP, EPA 420.1 or 420.2
Cyanide (T)	Colorimetric, EPA 335.2 or 335.3
Cyanide (A)	Colorimetric, before and after Cl_2

(1) Direct Current Plasma Analyzer = D.C.P.

TABLE 5-6

INDIANAPOLIS PRETREATMENT ORGANIC COMPOUNDS OF CONCERN FOR LABORATORY ANALYSIS

Compound	Suggested Analytical Procedure
Benzene	VOA (1)
1,1,1-Trichloroethane	NOA/ECD (2)
Chloroform	VOA/ECD
Ethylbenzene	VOA
Methylene Chloride	VOA
Naphthalene	VOA
Pentachlorophenol	BNA/ECD (3)
Para-Chloro-meta-cresol	BNA/ECD
Phenol	BNA
Toluene	VOA

1. VOA = Volatile Organics Analysis (Purge and Trap)
2. ECD = Electron Capture Detector
3. BNA = Base, Neutral, and Acid extraction followed by GC analysis

TABLE 5-7

INDIANAPOLIS PRETREATMENT COMPOUNDS INCLUDED IN BROAD SPECTRUM ORGANICS ANALYSES

Compound	Detection Possible By: Phenols (4AAP)	TOX (GC/ECD)
1,1,1 Trichloroethane	-	Yes
Chloroform	-	Yes
Methylene Chloride	-	Yes
Phenol	Yes	-
Pentachlorophenol	-	Yes
2-chloro-3-methylphenol	Yes	Yes
2-nitrophenol	Yes	-
2-chlorophenol	Yes	Yes
3-chlorophenol	Yes	Yes
2,3,5 Trichlorophenol	Yes	Yes

The Belmont Laboratory should not purchase and staff a Gas Chromatagraph/Mass Spectrophotometer (GC/MS) to provide capability for analyzing all 114 organic priority pollutants, because most have been shown to not be present in Indianapolis wastewaters. The City should have about four samples per year analyzed by an outside laboratory.

Other Industrial Pollutants

The Belmont Lab currently analyzes for petroleum oil and grease by the method that excludes vegetable and animal oils and grease. Because much of the City's concern over oils and greases has to do with their tendency to float and foul sewers and treatment facilities, the analytical method should be changed to include edible oils. The procedure should be run to determine whether floatable oil and grease is being discharged. This can be accomplished by running analyses on both mixed and unmixed samples. As indicated in the discussion of the Oil and Grease limit in the Industrial Wastewater Ordinance, any industrial discharge sample with less than 200 mg/l of Oil and Grease is considered to be comparable to the effluent from gravity separation (API separator or grease trap) equipment, and is therefore acceptable. The floatable and non-floatable distinction need only be made for AWT influent samples and industrial discharges above 200 mg/l Oil and Grease.

The analysis of samples for phenol should be by the 4AAP method, unless registers close to the ordinance limit for phenol, in which case the G.C. should be used to specifically quantify the phenol present and to check for the presence of particularly toxic phenolics, such as penta-chloro-phenol or para-chloro-meta-cresol. Similarly, the analysis for cyanide in industrial discharge samples should be by the procedure for total cyanide, unless the concentration is close to the ordinance limit, in which case both total and amenable cyanide should be run.

RECOMMENDED ADDITIONAL ANALYTICAL EQUIPMENT

While it is not absolutely necessary that the Belmont Lab acquire any additional equipment to meet the needs of the pretreatment program, there are a number of equipment purchases that could increase lab productivity and reduce the need for staff. In spite of the typically high cost of lab equipment, other labs have found it more economical to capitalize labor-saving equipment than to hire additional technicians when analytical volume increases.

The area of the lab of greatest concern for industrial monitoring is the metals sections. As mentioned earlier, the ability of the lab to operate the AA and DCP analyzers at maximum productivity will be enhanced by the purchase of auto-samplers for these machines. In particular, the use of an auto-sampler with the AA furnace can significantly improve accuracy. The alternative to auto-samplers is running the AA and ICP units on more than one shift and incurring significantly higher labor costs. These recommended equipment items are listed in Table 5-8, along with estimated costs.

TABLE 5-8

INDIANAPOLIS PRETREATMENT RECOMMENDED ADDITIONAL ANALYTICAL EQUIPMENT

Equipment Item	Estimated Cost
Auto-sampler for AA unit (Continuous aspiration and Articulated arm)	$ 7,000
Auto-sampler for DCP. unit (Continuous aspiration)	$ 6,500
Video-graphics data station for AA unit	$11,000
Data station for DCP unit w/graphics	$20,000
Background compensation equipment for DCP unit	$ 7,200
Additional Gas Chromatagraph	(not recommended for immediate purchase) $15,000
Laboratory sample logging and data aquisition computer	(not recommended for immediate purchase) $50,000
Central Dishwashing Machine	(to be installed only if lab changes over to centralized dishwashing) $20,000

Other than the equipment for speeding metals analyses, there are no major equipment items that the lab should purchase at this time for analytical work. There are however, two potential equipment purchases that the laboratory should begin to plan to acquire if the analytical workload increases to justify them. The first item is an additional G.C. unit, and the second is a computerized sample and data logging system.

A problem could develop in the future in the area of organics analyses if the lab is called upon to perform these on a high-volume basis. Currently, organic analytical capabilities are limited to a single gas chromatograph which is supplied with the full-range of options. As the options are specific to a given mode operation, and it may take from several hours to several days to change operating modes, there can be considerable equipment downtime and the optional accessories do not get used to their fullest extent. The downtime also limits the number of samples and delays sample turnaround time.

The acquisition, an additional gas chromatograph, and the dedication of the gas chromatographs to a given mode of operation is recommended rather than the reliance on a single unit to perform all of the analyses.

Consideration should be given to computerization of the laboratory for sample logging and data acquisition. Sample volumes are approaching the stage where this becomes cost-effective. With a potential for a one or two-year time period to purchase a computer system, it may be appropriate to direct efforts in this area in the near future.

RECOMMENDED OPERATIONAL IMPROVEMENTS

Problem areas in the laboratory are in dishwashing, sample storage, and in sample preparation for heavy metals and organics analysis. The dishwashing area is inadequate. Currently, the laboratory personnel wash their own glassware. As the analytical load of the laboratory increases due to increased industrial monitoring and start-up of the Advanced Wastewater Treatment Plants, improvements in dishwashing capacity and the assignment of a full-time dishwasher will increase laboratory productivity. Another option is the purchase of a central dishwashing machine, as indicated on Table 5-6.

Storage of samples prior to analyses may become a problem as the work load of the laboratory increases. This is currently not a problem, as there is no backlog of samples with current staffing and workload.

There is the potential for problems in the sample preparation area for heavy metals and organics analyses. Currently, the samples are prepared, digestions for heavy metals and extractions for organics, in the same rooms that standards are prepared. Under this type of arrangement, cross contamination problems can result when making up standards and doing spikes with concentrated solutions. It would be preferred to have these functions done in separate rooms. An increase in the area for organics extraction would also be desirable, as its capacity is limited.

As mentioned in the section above regarding equipment purchases, the laboratory may soon be reaching the point at which the volume of samples and data overwhelms the current systems for logging and records keeping. It may be wise to add designated staff to manage samples and data as well as to plan and implement improved sample and data management systems.

The cyanide analytical area in particular, and phenols and oil and grease to a lesser extent, will have to be staffed up to meet the needs of the pretreatment program. It may be possible to alleviate some of the staffing problem by shifting to the use of the Technicon Auto-analyzer for the cyanide analysis, although this could result in accuracy problems if Indianapolis wastewater components interfere with the technicon procedure. Staffing problems in phenols and oil and grease areas may require shift work.

Finally, the Belmont Laboratory should conduct a review of its procedures for storage and handling or standards for organics analysis by G.C. Many of the priority pollutants are carcinogens or are otherwise hazardous to personnel who must work with them. Safety regulations have been published by OSHA and various insurance agencies, and these should be applied in the Belmont Lab. This may require containment facilities and/or additional safety shower facilities.

REGIONAL LABORATORY ASSESSMENT

General

The concept of establishing the Belmont Laboratory as a regional laboratory of POTW's in central Indiana grew out of concern that the need to analyze infrequent samples for a wide range of priority pollutants would result in the purchase and under-utilization of atomic absorbtion and gas chromatagraphic equipment by many different POTW's. A regional laboratory should be able to run complex analyses with lower costs and better quality control than a collection of many smaller laboratories. This conept can be tested for feasibility by answering the following questions:

- Will the Belmont Laboratory have significant under-utilized facilities and equipment required for pretreatment program analytical work?
- Are there other POTW's in the region around Indianapolis which need to analyze priority pollutants but lack the facilities?
- Would the establishment of a public regional laboratory have significant benefit compared to reliance on private commercial laboratories?

Belmont Capacity Utilization

The needs of the Indianapolis ISB for industrial pollutants can be considered in terms of metals and organics when discussing equipment and facilities. The Belmont Lab runs an atomic absorbtion unit for analysis of metals. As has been discussed above (see Tables 5-2 and 5-4), the number of samples analyzed for metals in the Belmont Laboratory has been limited due to staffing. The lab has increased the staffing for its atomic absorbtion equipment over the past year, and it appears that over the next several years, the metals analysis needs of the ISB can be matched fairly well to the capacity of the Belmont Laboratory. This will achieve a balance that combines full utilization of lab equipment and an acceptable frequency of analysis of metals in industrial discharges in Indianapolis, as defined in Chapter 3.

The Belmont Laboratory is equipped with a gas chromatagraph for analysis of organic compounds. This equipment is suited to the accurate analysis of only limited numbers of organics, simply because the equipment must be readjusted, standardized, and in some cases modified (as by changing detectors) for each compound. In general, laboratories have found that GC/MS equipment is necessary to economically analyze for large numbers of compounds on the same sample. As indicated earlier in this report, Belmont has very little need to analyze for large numbers of organic compounds, and what need there is can be met by sending about four samples per year to one of the five to ten private laboratories that market GC/MS analytical services on a national basis. On the other hand, the Belmont Lab needs the capability to analyze about ten to fifteen specific organic compounds (solvents and phenolics) that have been found to be significant in the Indianapolis wastewater. The GC equipment at the Belmont Lab is suitble for analysis of these compounds. It is probable that with increased staffing, more replicates of organic analyses could be run than will be required by the ISB using the existing Belmont equipment. However, the specific organic compounds of interest to the ISB may not be important to other POTW's, and the development of procedures and equipment modifications to detect compounds of interest to other POTW's would decrease the availability of trained staff for ISB testing. In other words, while ISB needs may not load the GC equipment to capacity, they will fully utilize the trained analytical staff.

Regional Demand for Analytical Services

The pretreatment project team surveyed 27 public treatment plants in the region around Indianapolis and asked a series of questions designed to help evaluate the demand for public regional lab facilities. A summary of the results of the survey is presented in Table 5-9. The survey found that there is significant interest in metals analyses, but little interest in organics analyses. Secondly, those treatment plants most interested in metals analyses had proceeded to procure and staff their own atomic absorbtion equipment. Because these other labs have their own equipment, there is little demand for regional metals analysis capability. In short, other POTW's in central Indiana are either not interested in running priority pollutant analyses, or they are already operating facilities capable of running the analyses they do need. The cost of analytical equipment and staff does not seem to be a problem for those POTW's in the region with the need to monitor priority pollutants. Thus, there is no strong demand for a regional public analytical laboratory.

TABLE 5-9

INDIANAPOLIS PRETREATMENT
RESULTS OF SURVEY OF LABORATORIES IN INDIANAPOLIS REGION

			Metals Analyses			Organics Analyses				
Community	Treatment Plant Size (mgd)	Industrial Discharge	No. of Samples per year	In-house AA or Outside Lab.	Expected Change in No. of Samples?	No. of Samples per year	Organics of Interest	In-house or Outside Lab	Expected Change in No. of Samples?	Other Toxics Analyses (CN, Phenols)
Anderson	27	4	250	In-house AA	Recent Cutback	0	—	—	No Change = N.C.	Occasional
Bedford	6	3-5	12	Outside	No Change = N.C.	Some	PCB's	Outside	N.C.	No
Bloomington	20	5	120	In-house AA	N.C.	150	PCB's	In-house GC	N.C.	No
Columbus	12	13	600	In-house AA	Decrease	0	PCB's	In-house GC	Increase	Occasional
Connersville	10	7	750	In-house AA	N.C.	0	—	—	N.C.	CN
Elwood	3	2	6	In-house AA	Increase: New Plant	0	—	—	N.C.	No
Fort Wayne	No Response	—	—	—	—	—	—	—	—	—
Frankfort	5	4	236	In-house AA	N.C.	0	—	—	N.C.	Occasional CN
Franklin	2	4	Some	Outside	N.C.	0	—	—	N.C.	No
Greenfield	3	4	764	In-house AA	N.C.	0	—	In-house GC	Increase	CN
Greenwood		- Plant is Closed -		—	—	—	—	—	—	—
Huntington	5	10	150	In-house AA	N.C.	0	—	In-house	Increase	Phenols
Kokomo	30	50	6,000	In-house AA	N.C.	0	—	Outside	Increase	CN
Lafayette	16	15	500	Outside	Increase	Some	—	Outside	—	CN
Logansport	—	Some	Some	In-house AA	Increase	0		—	Increase	No
Madison	3	10	300	Outside	N.C.	0		In-House GC	—	CN, Phenols
Marion	12	30	262	In-house AA	Increase	0		—	N.C.	No
Martinsville	-	None	0	None	N.C.	0		—	N.C.	Nop
Muncie	24	30	300	In-house AA	Increase	A few	PCB's	Outside	N.C.	CN, Phenols
New Castle	16	6	0	None	Increase	0	0	—	N.C	No
Seymour	4	10	0	In-house AA	Will do 6/yr	0	PCB's	Outside	Will do 4/yr	CN, Phenols
Shelbyville	3	0	0	None	N.C.	0	0	—	N.C.	No
Speedway	7	5	0	None	Increase	0	0	—	N.C.	No
Terre Haute	48	90	180	In-house AA	Increase	Some	PCB's	Outside	N.C.	No
Vincennes	4	3	52	Outside	N.C.	0	—	—	N.C.	No
Wabash	5	0	Some	Outside	N.C.	0	—	—	N.C.	No
Washington	4	1	Some	Outside	N.C.	Some	—	Outside	N.C.	No

Public vs Private Regional Facilities

If the Belmont Lab offered its service to other POTW's, it would essentially be entering the marketplace for commercial laboratory services. Unless operational funding for the Belmont Lab were provided by a Federal or State agency, the lab should charge for any services which benefit people who do not support the lab through Indianapolis taxes or user fees. The only potential benefit to the City of Indianapolis in operating its existing facilities as a regional laboratory is the possible profit to be earned. Such profits would not be large because the commercial laboratory business is quite competitive. Some City services and programs would probably suffer if attention is diverted into the profit-making concerns of a commercial lab. Because Indianapolis does not need extensive additional facilities and equipment (GC/MS) to conduct its pretreatment program, it is not possible to justify arranging Federal or State funding of a regional laboratory at Belmont.

Conclusion

The City of Indianapolis should not attempt to establish the Belmont Laboratory as a Regional Laboratory, because the lab does not currently have excess capacity nor does it need additional facilities to support the ISB monitoring program, because there is relatively little demand for regionalized public laboratory services in central Indiana, and because the City of Indianapolis would not benefit significantly from running a regional laboratory service in competition with private laboratories.

APPENDIX A

APPENDIX A

EXAMPLE INDUSTRIAL SAMPLING TRAINING PROGRAM COURSE DESCRIPTION

General. The following course description outline the type of training program that will need to be set-up to instruct sampling crews in the proper procedure for taking and preserving samples of various types. Separate course units will be required to train crews in safety procedures, equipment, sample composting, sampling custody requirements, and the transportation of samples.

Course Unit I - Priority Pollutant Sample Types. Sampling crews will encounter a variety of sample types. Each sample type requires different methods of taking and handling. Sampling crews must be instructed in the correct procedures for bottling each of the following types:

- Volatile Organics
- BNA Extractable Organics
- Pesticides
- Heavy Metals
- Cyanide
- Asbestos
- Total Phenols

It is essential that crews know what sort of sampling and bottling techniques are required for each type of sample. As an example, crews should be aware that it is essential to take volatile organics samples using a container with "no free head space" during the collecting period to prevent the release of volatile organics from the liquid. Similarly, crews should be aware that organic samples should only be permitted to come into contact with the glass, stainless steel, or teflon portions of sampling devices in order to prevent absorption of organics into the sample material.

Course Unit II - Preservatives Required. Sampling crews will require instructions in the correct preservatives to be utilized with each sample type. Preservatives to be considered will include:

- Sodium Thiosulfate (for organics)
- Nitric Acid (for metals)
- Sodium Hydroxide (for cyanides)
- Sulfuric Acid (for phenols)
- No Preservatives Required (for asbestos, etc.)

Proper infomation about the correct preservative to be utilized with each sample is essential to ensure that the samples arrive at the laboratory in an undeteriorated state. Sampling crews will also require instruction on the need for keeping samples at proper temperatures and delivering samples to the laboratory quickly to preserve valid samples. For example, crews must be aware that heavy metals samples do not require refrigeration, but must be preserved with nitric acid. Phenol, on the other hand, must be kept on ice before shipping and should arrive at the laboratory within 30 hours of sampling. Trihalomethanes (THM's) require preservation with sodium thiosulfate, but do not require refrigeration and can be held for up to three days before analysis. Numerous other examples of preservation problems and techniques will need to be covered in this course unit.

Course Unit III - Sampling Methods To Be Utilized. It is essential that any monitoring and enforcement program be based on samples which are valid and meaningful. To this end, sampling crews must be trained in the proper techniques for taking and preparing samples. Crews should be trained to know when grab samples will be sufficient for a particular purpose and when automated samples must be used. Maintenance of sampling equipment and preparation of sample bottles are important parts of the sampling operation to be covered. This course unit will discuss:

- Grab Samples (non-automated)
    1. Open Channel and manhole
    2. Pressurized tap
- Automated Samples
    1. Operation and set-up
        a. manhole
        b. industry and treatment plant
    2. Clean-up and preparation
        a. sample bottle washer and preservatives
        b. maintenance and battery recharge

Sampling crews should be aware of the procedures for taking each type of sample and of the values and limitations of each type. For example, grab samples can be useful for quickly indicating the existence of a problem, but tend to be suspect as legal evidence. Composite samples generally provide more concrete information on a discharge, but are more expensive and more complicated to take.

The necessity to ensuring that sample bottles are clean and uncontaminated will be covered in this unit. The care and maintenance of sampling equipment will also be considered.

Course Unit IV - Safety For Confined Space Entry. An absolutely essential component of any sampling training program is a complete and well planned set of safety procedures. Sampling crews lives may depend on the throughness of their knowledge of proper safety procedures. This course unit should cover:

- Traffic Control
- Ventilation
- Gas Monitoring
- Full-body Harness and Tripod

There is an element of danger involved in each step of the sampling process. These dangers need not be allowed to cause casualties if sampling crews are well-versed in proper procedures and alert to the need for caution in every sampling step from controlling the flow traffic around the sampling site to ensuring that samples breathe only clean air and are properly harnessed before entering a manhole.

Course Unit V – Flow Meter and Primary Measurement Device. This course unit will cover:

- Installation of Flume
- Installation of Flow Meter
- Operation of Flow Meter
- Calibration
- Mechanical Connections

No sampling program can function properly unless crew members are thoroughly trained in the use of flow meters and other measurement devices. This course unit will take sampling crews step-by-step through the procedures of setting up and operating this equipment.

Course Unit VI – Sample Composting. There are a variety of methods for compositing samples. Each has its own assets and limitations. This course unit will discuss:

- Sample compositing at treatment plant, manholes, and industy sites

    1. flow composite - automatic
    2. flow composite - manual
    3. non-flow composites

Flow composited sampling is useful where an enforcement action is contemplated, and samples of high reliability are required. Both automatic and manual flow composites provide reliable measurement of discharge composition, but the automatic technique requires that crews be well trained in the care and maintenance of equipment. Crew members should also be trained in manual techniques. These require a sound understanding of the theory of composite sampling so that crews can be relied on to utilize good techniques in putting together the manually composited samples.

Non-flow composited samples are sufficient for regular monitoring purposes. They provide a statistically accurate picture of wastewater composition, but may be unsufficient for legal purposes. Crews must be instructed in such matters as recording changes in flow volume while samples are being composited.

Course Unit VII - Chain-of-Custody. Any enforcement program relies on samples whose integrity is beyond question. For this reason, it is absolutely essential to instruct sampling crews in the necessity for following established chain-of-custody procedures with the utmost care. Crews must be made aware of the need for handling samples as little as possible and by as few persons as possible. Careful and accurate records must be made and attached to the sampling bottle each time it changes hands. These steps must be followed to ensure that samples are acceptable in a court of law.

Course Unit VIII - Sample Transportation. Once samples are carefully bottled, preserved, and recorded, it is essential that they arrive at the laboratory in good condition. To ensure that the lab receives valid samples, this course unit will discuss:

- Storage
- Shipping Containers
- Blue Ice

Different samples have different requirements. Crews should know how long each sample can be stored, what sort of container it should be shipped in, and whether or not is should be kept on ice. These problems will be discussed in detail.

Course Unit IX - Summary. This course unit will summarize all of the major points covered in previous units. An attempt will be made to unify the major points into a coherent and logical whole.

APPENDIX B

APPENDIX B

LABORATORY STANDARD OPERATING PROCEDURES

GENERAL

Once samples have been collected and transported to the laboratory, it is imperative that proper analytical laboratory procedures are employed. This section addresses four areas of concern with respect to standard operating procedures namely: (i) sample handling, (ii) analytical procedures, (iii) reporting procedures, and (iv) legal considerations. Each of these areas are discussed in detail below.

SAMPLE PRESERVATION

Complete and unequivocal preservation of samples, either domestic sewage, industrial wastes, or natural waters, is a practical impossibility. Regardless of the nature of the sample, complete stability for every constituent can never be achieved. At best, preservation techniques can only retard the chemical and biological changes that inevitably continue after the sample is removed from the parent source. The changes that take place in a sample are either chemical or biological. In the former case, certain changes occur in the chemical structure of the constituents that are a function of physical conditions. Metal cations may precipitate as hydroxides or form complexes with other constituents; cations or anions may change valence states under ceratin reducing or oxidizing conditions; other constituents may dissolve or volatilize with the passage of time. Metal cations may also absorb onto surfaces (glass, plastic, quartz, etc.), such as, iron and lead. Biological changes taking place in a sample may change the valence of an element or a radical to a different valence. Soluble consitutents may be converted to organically bound materials in cell structures, or cell lysis may result in release of cellular material into solution. The well known nitrogen and phosphorus cycles are examples of biological influence on sample composition. Therefore, as a general rule, it is best to analyze the samples as soon as possible after collection. This is especially true when the analyze concentration is expected to be in the low ug/l range.

Methods of preservation are relatively limited and are intended generally to (i) retard biological action, (ii) retard hydrolysis of chemical compounds and complexes, (iii) reduce volatility of constituents, and (iv) reduce adsorption effects. Preservation methods are generally limited to pH control, chemical addition, refrigeration, and freezing.

Several references are available with detailed instructions on sample preservation (APHA, 1975; EPA 1979). A summary of suggested sample preservation techniques are shown in Table B-1.

ANALYTICAL PROCEDURES

A detailed discussion of the various analytical procedures is presented in Chapter 5 of this report.

Laboratory personnel should periodically review various literature sources to ensure the utilization of the best accepted methods. Quality control programs for laboratories which the City has analytical contracts with should be monitored on a routine basis for accepted laboratory procedures.

REPORTING PROCEDURES

Laboratory reporting procedures have been prepared by the Water Pollution Control Federation (WPCF, 1981). These procedures should be modified to meet the needs of Indianapolis. Data collected in the laboratory should remain confidential. Analytical results should be compiled with a permanent copy kept on file at the laboratory. Laboratory data books and data sheets should be kept bound if possible. Copies of the data results should be forwarded to ISB for monitoring and enforcement activities and to the Industrial Pretreatment Administrator for data logging activities.

LEGAL CONSIDERATIONS

General

All pretreatment program sampling and laboratory analysis must satisfy certain legal requirements to ensure that the results can serve as evidence in any legal proceedings. In general, the integrity of the sample must be ensured. This is accomplished through a strict sample handling chain of custody.

Sample Integrity

The integrity of a sample begins with the selection of the sampling stations and continues through the final accurate recording of the analytical results. Each step of the process must follow the prescribed procedures to ensure the integrity of the results. The procedures discussed in the preceeding section must be followed or the care exercised in the chain of custody procedure will be of little value.

Chain of Custody

General Procedures. The essence of chain of custody procedures is being able to prove that a sample has not been tampered with. The primary objective is to create an accurate written record which can be used to trace the possession of the sample from collection through its introduction as possible evidence. Custody consists of either a) actual physical possession, b) in view after being in physical possession or c) locked up so no one can tamper with it.

Rules for Sample Collection. 1) Handle the samples as little as possible.

2) Obtain samples using appropriate sampling techniques (as described earlier in this chapter).

3) Attach a Chain of Custody Record bottle tag (Appendix J) to the sample container at the time of sample collection. Tag should contain information on sample number, date, time, source, analyses required, name of person doing sampling, and witnesses. Tag should be signed and dated (including time) by sample collector. Sample container should then be sealed so the tag cannot be removed without breaking the seal.

4) Field measurements should be recorded in a bound field notebook or log. The field data should be in sufficient detail to refresh the memory of sampling personnel if necessary. A separate set of field notebooks should be maintained and stored in a safe place where they can be accounted for at all times. Entries should be signed by the person taking the sample and errors crossed out with one line and initialed.

5) The person taking the sample is responsible for the care and custody of the sample and must assure that each container is in his physical possession or view at all times or is stored such that it cannot be tampered with.

Transfer of Custody. When transferring custody the transferree must sign and record the date and time on the Chain of Custody record. The field custodian is responsible for properly packaging and dispatching samples to the appropriate laboratory for analysis. Samples should be packaged to avoid breakage and shipping containers should be padlocked for shipment to the receiving lab or gummed seals utilized to insure that tampering can be detected.

All samples should be accompanied by a sample transmittal form which includes information identifying the contents. If samples are delivered to the lab when appropriate personnel cannot receive them they must be locked in a designated area so that no one can tamper with them.

Laboratory Custody Procedures. The lab should have two full time employees designated as sample custodian and alternate for sample handling. In addition the lab should have a clean dry isolated room that can be securely locked from outside as a "Sample Storage Security Area". The sample custodian must maintain a bound log book to record all appropriate information about the sample.

The principal of "chain of custody" is that samples should be handled by the minimum possible number of persons. Immediately upon receipt the custodian should affix a number to the attached tag, record the required information in the log book and preserve the sample if that has not already been done. The sample should then be stored in a locked sample room. The custodian is the only person who should distribute samples to appropriate laboratory personnel performing analyses. The custodian should enter in the log book information about who received the sample and when.

If a seal was used on the sample container it should be examined prior to opening for any signs of tampering. The analyst should record in his/her log book the name of the person from whom the sample was received, whether it was sealed, identifying information, procedures performed and test results. He/she should sign and date his/her notes as a permanent lab record.

Lab personnel are responsible for the care and custody of the sample once it is handed over to them. Once the sample testing is completed the unused portion of the sample along with any identifying tags and seals should be returned to the custodian who will make appropriate entries in the log.

Samples, tags, and laboratory records of tests should be destroyed only upon the order of the lab director.

APPENDIX C

APPENDIX C

References

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